SCHOOL SCIENCE AND MATHEMATICS

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Emil Lavern Massey
1896-1948

Emil Lavern Massey died in Detroit on November 9, 1948. News of the death moved deeply all who knew him. It was a shock to lose such a loyal friend. He was president of the Central Association of Science and Mathematics Teachers in 1944. His fellow members and successors in office knew him as a most willing and efficient worker. Hailing from Indiana, he exemplified Hoosier hospitality. Moving to Michigan, he lived and served the tempo of Detroit the dynamic. His influence extended from industry and from education to be felt not only in the middle west but in distant places where scientists and teachers worked and met.

Mr. Massey was thoughtful of others—to the littlest detail of human relations. This was only one aspect of evidence of his appreciation of the finer possibilities in living. He was quickly aware of the new, even the emerging, notions in science and in human relations, yet more than comfortably supported by those which had already been tested and proved. A subtle sense of humor drew listeners close, even to casual conversation. These characteristics are particularly notable in view of the fact that his health was impaired by a heart condition since birth.

Mr. Massey was born on October 9, 1896, in Mier, Indiana. He was graduated from high school in 1914, in Jonesboro, Indiana. He received the bachelor of science degree in chemistry in 1917, from Tri-State College, at Angola, Indiana; the bachelor of arts degree in education in 1924, from the University of Michigan; and the master of arts degree in education in 1931, from the University of Detroit.

From 1917 to 1923 he worked in industry in Detroit, Michigan. During the first two and one-half years, he was assistant chemist at the Detroit Testing Laboratory. During the three and one-half years

ending in 1923, Mr. Massey served as chief chemist at the Detroit Copper and Brass Company. Then he returned to study, this time at the University of Michigan, preparatory to entrance into the teaching profession.

On September 2, 1924, he received his teaching appointment in the Detroit Public Schools and was assigned to Northern High School. On February 1, 1926, he was transferred to the new Central High School. He taught chemistry and sponsored the Hi-Y club. In September, 1926, he was promoted to Head of Department. In 1936, one half of his time was requested to assist the High School Committee and the Division of Instruction in the preparation of courses of study and other instructional material. This transfer was made effective on September 7. In September 1937, the transfer was made full time with promotion to Supervising Instructor of Science. On July 1, 1941, he was promoted to the dual role of Assistant Professor at Wayne University and Supervisor of Exact Science. In February, 1944, he was promoted to Associate Professor at Wayne University and Director of Exact Science in the Division of Instruction, on a twelve months basis. On April 23, 1946, he began a six months leave of absence to improve his health. He cut this short and returned to work on August 6.

Professionally, he was exceptionally active, accepting many challenges from the start. His University of Michigan professors, C. O. Davis, C. S. Berry, R. D. Horn, and W. H. Pfeiffer, were unanimous in sending him off to teach with the recommendation "Very good in scholarship, makes good impression, responsible, mature, hungry for teaching, modest." Honors and affiliations resulted naturally. Following are the names of organizations included among those claiming him for membership: National Education Association; National Science Teachers Association (Director, 1944; Regional Vice-President, North central, 1948); American Association for the Advancement of Science (Fellow 1946); Central Association of Science and Mathematics Teachers (Director, 1941, 1942, 1943, 1945; President, 1944); Sigma Pi Sigma Fraternity; Phi Delta Kappa Fraternity; Engineering Society of Detroit; Kiwanis.

It takes only a sentence to mention that he spent much of his leisure time at his lake cottage "back home in Indiana" or entertaining his family and friends at the Detroit Yacht Club. Volumes would be required to indicate the pleasure he realized from such associations. As a scientist, teacher, citizen, he lived a meaningful life.

He is survived by his wife, Esther (nee Unruh), and his son, Dr. Robert Massey.

ALLEN F. MEYER

Arthur T. Sims
1902-1948

Arthur T. Sims, a teacher of mathematics for the past eleven years at the George Washington High School, Indianapolis was born in Frankfort, Indiana, October 21, 1902.

The faculty and students who knew him were always conscious of his sincerity and complete willingness to give his best on every occasion. He presented his class work in an interesting manner, bringing in much additional material to enliven the ordinary class routine.He was a graduate of Wabash College and Indiana University. His death was due to a heart attack October 27, 1948. He is survived by his wife and four sons.

VIVIAN B. ELY

ECHOES OF THE 1948 CONVENTION

J. E. POTZGER
Butler University, Indianapolis, Indiana

The Claypool Hotel at Indianapolis hummed with C. A. S. M. T. activity from Thursday, November 25 to Saturday, November 27. There was the ceaseless flow of conversation as friends from many states met on the mezzanine floor. Mr. Fred D. Leonhard and his membership committee, aided by the local membership committee, registered one of the largest number of convention guests on Thursday evening (110) in the history of the Association. Mimeographed summary reports of the five chairmen working on the five new research projects proposed by the Policy Committee last year were distributed to inform members on the progress made by these committees.

A program bringing speakers on discoveries and work of world significance fired the interest of the three Indianapolis papers. The local publicity chairman, Miss Mona Jane Wilson, was kept busy providing copy to editors or arranging interviews for reporters and photographers. Upon arrival at Indianapolis, speakers on the General Program were met either at the airport or at the Union Station and escorted to the Claypool, and when homeward bound, they were again given friendly escort to the stations.

Sociability was the keynote of the convention activities. This was also in evidence at the informal reception preceding the banquet. About 220 guests participated in the program of a beautiful banquet. Tables seating groups of ten, decorated in Indiana autumn colors, were spread out in the quaint Riley Room where excerpts from poems of the Hoosier poet, James Whitcomb Riley, decorated the walls of

the hall. Vases made from small pumpkins displayed decorative grasses, bittersweet, milkweed pods and multicolored autumn leaves. Dr. Paul L. Trump of Wisconsin Univ., toastmaster of the evening, seasoned the passing activities with sparkling humor which assured us that a dean of men need not necessarily be a pessimist perpetually looking for trouble to solve. Dr. Leo J. Brueckner's message on the schools of Germany gave the thinking teacher much to ponder about. It is decidedly easier to be born into a democratic form of government than to be trained into one, especially when the period of training is encumbered by so many physical difficulties.

Publicity in the daily press was a decided highlight of the convention. We had attention not only during the session period but also before and after the convention days. The *Star* and the *News* displayed a large activity picture, three columns in width, the *Times* presented a spectacular half page picture display of speakers and of the Atlantic and work on the Mid-Atlantic Ridge expedition. This was followed by a lengthy article on the convention program in general. All three papers brought in bold headlines resumes of addresses by the General Program and Banquet speakers. Totals in inches of space, single column, given us by the three papers were: *Times* $87\frac{1}{2}$; *Star* $63\frac{1}{2}$; *News* $42\frac{1}{2}$.

A delightful informal social hour followed the banquet, where performances by local highschool students and community singing formed the background for a group of educators very much at ease.

The weather was most excellent on Thursday and on Saturday, so the guests traveling by auto had an opportunity to enjoy the Indiana late autumn landscape.

It was stimulating to have a nice turnout for the business meeting on Saturday morning; this is the one opportunity for the members at large to participate actively in the Association's business. The Central Association is very active at present with several large projects and with the preparation of an anniversary book which will present tendencies in the teaching field and changes in teaching of science and mathematics which have taken place during the past fifty years. Several sample covers for the book were on display and members had an opportunity to vote for their choice of cover.

Among the 500 guests at the convention were representatives from Oregon, Texas, New Jersey and Canada, and visitors from such widely scattered geographical locations constituted a living tribute to the slogan of SCHOOL SCIENCE AND MATHEMATICS, "WE COVER THE EARTH."

Your new president is Dr. Charlotte L. Grant of Oak Park, Illinois. Plan now to attend the 1949 convention in Chicago.

NEW AIDS FOR TEACHING THE PERIODIC LAW[1]

GEORGE A. SCHERER
Earlham College, Richmond, Indiana

Ever since the memorable work of Mendelyeev in 1869, chemists and physicists have sought improvements in the periodic system of the elements. The important thing that Mendelyeev recognized was that valence and other properties are related to atomic weight. But as the knowledge of the structure of atoms has increased, naturally more attention has been given to classifications based on atomic structure.

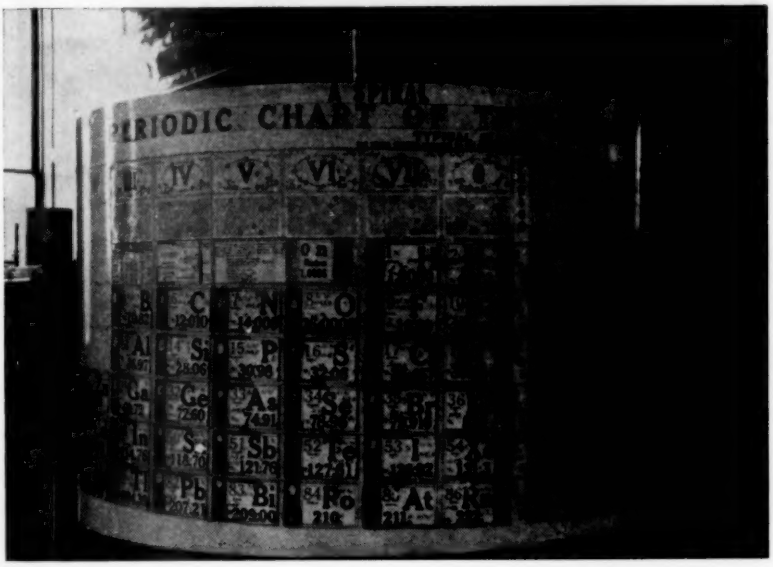


FIG. 1. Typical Elements on Spiral Periodic Chart.

It is now clearly known that the properties of the elements are directly associated with the structure or electronic configurations of the atoms. Thus chemical similarity between elements is bound up with a similarity in the number of electrons in the outer shells of their atoms. The inactivity of the inert gases is associated with their completed outer shells, the great activity of the alkali metals with their single outer electrons and activity of the halogens with their groups of seven outer electrons. In terms of these outer electron shells, the periodic law may be stated: when the elements are arranged in order of in-

[1] Presented before the Chemistry Section of the Central Association of Science and Mathematics Teachers, Indianapolis, November 26, 1948.

creasing atomic number, similar numbers of electrons occur in the outer shells of their atoms at regular intervals.

These relations are best shown by a continuous curve which connects the elements in the order of their atomic numbers and which classifies the elements according to electronic configurations. A helical spiral on a right circular cylinder serves very well. Figures 1, 2 and 3 show three views of a classroom model of such a spiral periodic chart and figure 4 shows a student model which can be cut out with scissors and assembled as a circular cylinder which is stiff enough to stand by itself yet the two pieces can easily be taken apart and kept in the student's notebook.

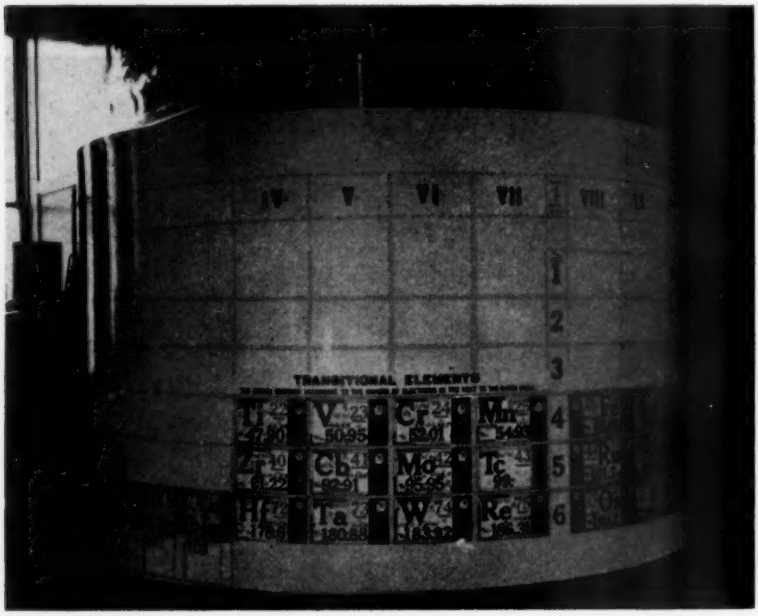


FIG. 2. Transitional Elements on Spiral Periodic Chart.

On such a spiral periodic chart it is easy to follow the change in the electronic structure of atoms and the manner in which the shells of electrons are built up. On this chart there are thirty-two columns divided into three major classes of elements, namely, the Typical Elements, the Transitional Elements, and the Rare Earth Elements.

The Typical Elements are those in the usual groups III b, IV b, V b, VI b, O, I a, and II a, which have a number of valence electrons equal to their group number. They are the elements in which the outer shell of electrons is being built up from one to the maximum number (eight for all shells except the first which is two). Included are

all the elements of periods 1, 2 and 3 and part of the elements of periods 4, 5, 6 and 7.

Period I contains hydrogen and helium, in which a stable configuration is attained. Period 2 is made up of the elements lithium through neon, which has a complete and stable configuration and is thus an inert element. Period 3 consists of the elements sodium through argon, which is an inert element. Period 4 begins with potassium and is complete with the inert element, krypton. Only eight of the eighteen elements in this period are Typical Elements. Period 5, rubidium through xenon, is like period 4 in having only eight of its eighteen elements as Typical Elements. Period 6 has thirty-two elements,

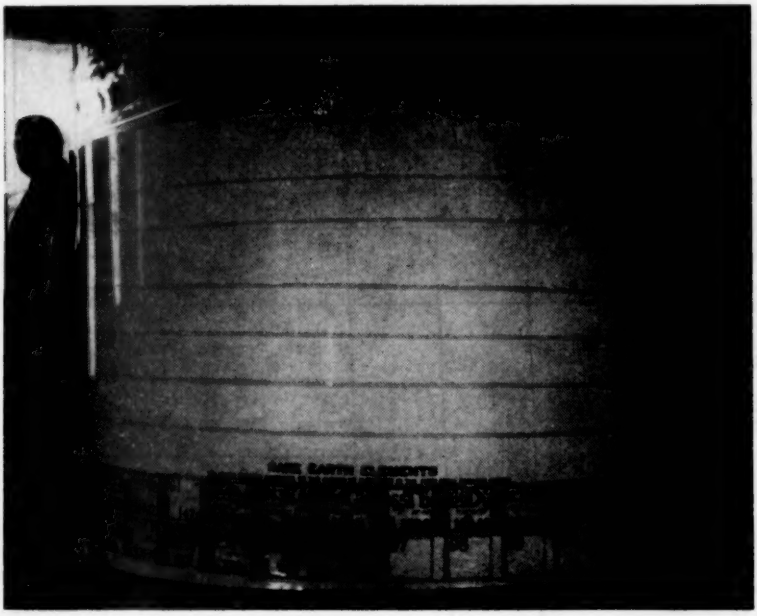
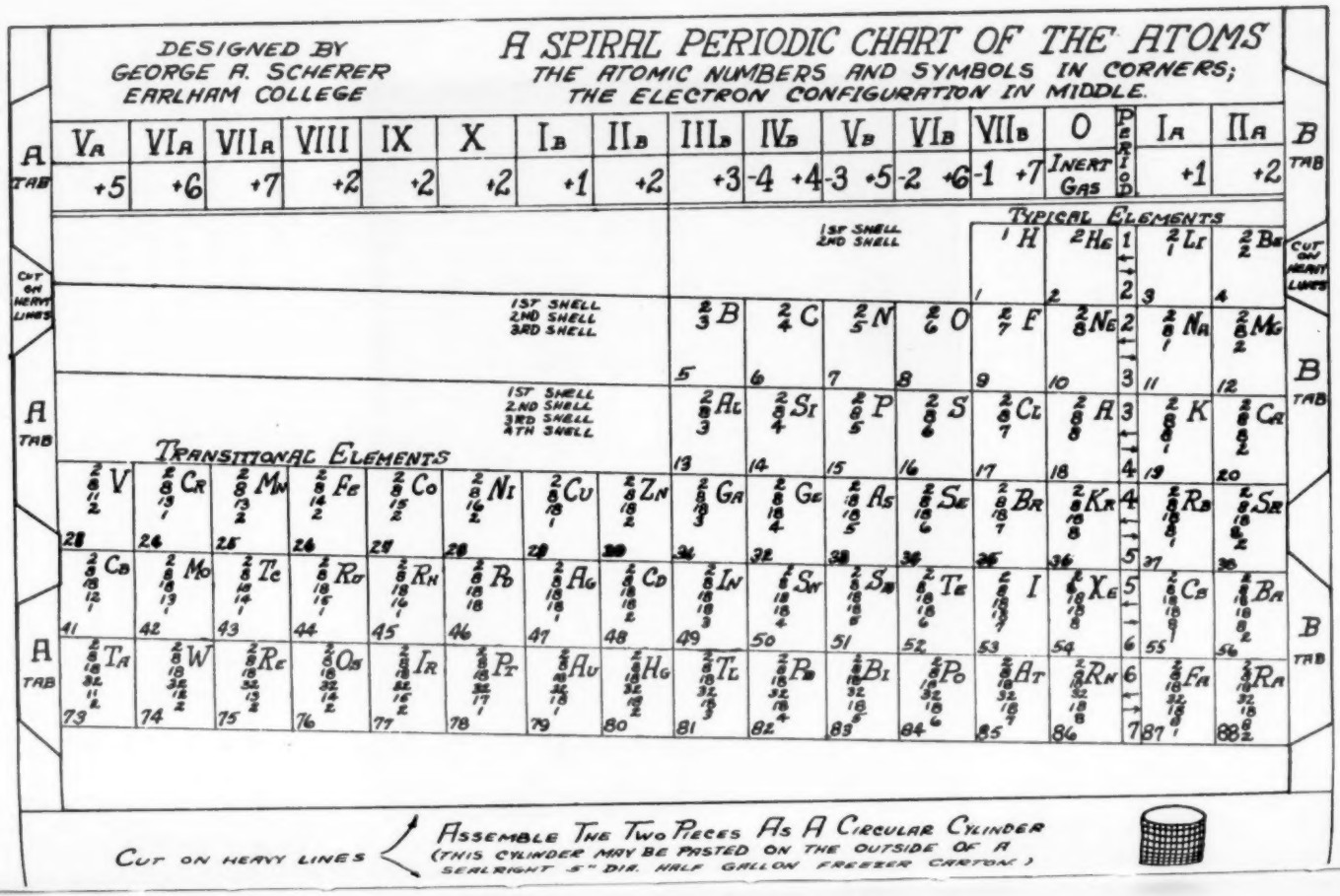


FIG. 3. Rare Earth Elements on Spiral Periodic Chart.

cesium through radon, but only has eight Typical Elements. Period 7 is incomplete and has only two Typical Elements.

Electronic structure theory emphasizes the intermediate and central position of the inert gases. The Typical Elements are those whose electronic structures are closely related to the inert gas structures. The periods of these elements are clearly shown in their relationship to the inert gas structure. The inert gases form the natural link between the elements which by gain or loss of electrons form simple ions which have inert gas structures.

The elements in groups III a, IV a, V a, VI a, VII a, VIII (or VIII, IX and X), I b, and II b, Transitional Elements, have, as a rule, two


DESIGNED BY
GEORGE A. SCHERER
EARLHAM COLLEGE
A SPIRAL PERIODIC CHART OF THE ATOMS
THE ATOMIC NUMBERS AND SYMBOLS IN CORNERS;
THE ELECTRON CONFIGURATION IN MIDDLE.
A TAB
B TAB
CUT ON HEAVY LINES
VA +5
VIA +6
VIIA +7
VIII +2
IX +2
X +2
IB +1
IIB +2
IIIB +3
IVB -4 +4
VB -3 +5
VIB -2 +6
VIIB -1 +7
O INERT GAS
PERIOD
IA +1
IIA +2
TYPICAL ELEMENTS
1ST SHELL
2ND SHELL
3RD SHELL
4TH SHELL
TRANSITIONAL ELEMENTS
1 H
2 He
3 Li
4 Be
5 B
6 C
7 N
8 O
9 F
10 Ne
11 Na
12 Mg
13 Al
14 Si
15 P
16 S
17 Cl
18 A
19 K
20 Ca
28 V
24 Cr
25 Mn
26 Fe
27 Co
28 Ni
29 Cu
30 Zn
31 Ga
32 Ge
33 As
34 Se
35 Br
36 Kr
37 Rb
38 Sr
41 Cb
42 Mo
43 Tc
44 Ru
45 Rh
46 Pb
47 Ag
48 Cd
49 In
50 Sn
51 Sb
52 Te
53 I
54 Xe
55 Cs
56 Ba
73 Ta
74 W
75 Re
76 Os
77 Ir
78 Pt
79 Au
80 Hg
81 Tl
82 Pb
83 Bi
84 Po
85 At
86 Rn
87 Fr
88 Ra
CUT ON HEAVY LINES
ASSEMBLE THE TWO PIECES AS A CIRCULAR CYLINDER
(THIS CYLINDER MAY BE PASTED ON THE OUTSIDE OF A
SEALRIGHT 5" DIA. HALF GALLON FREEZER CARTON.)

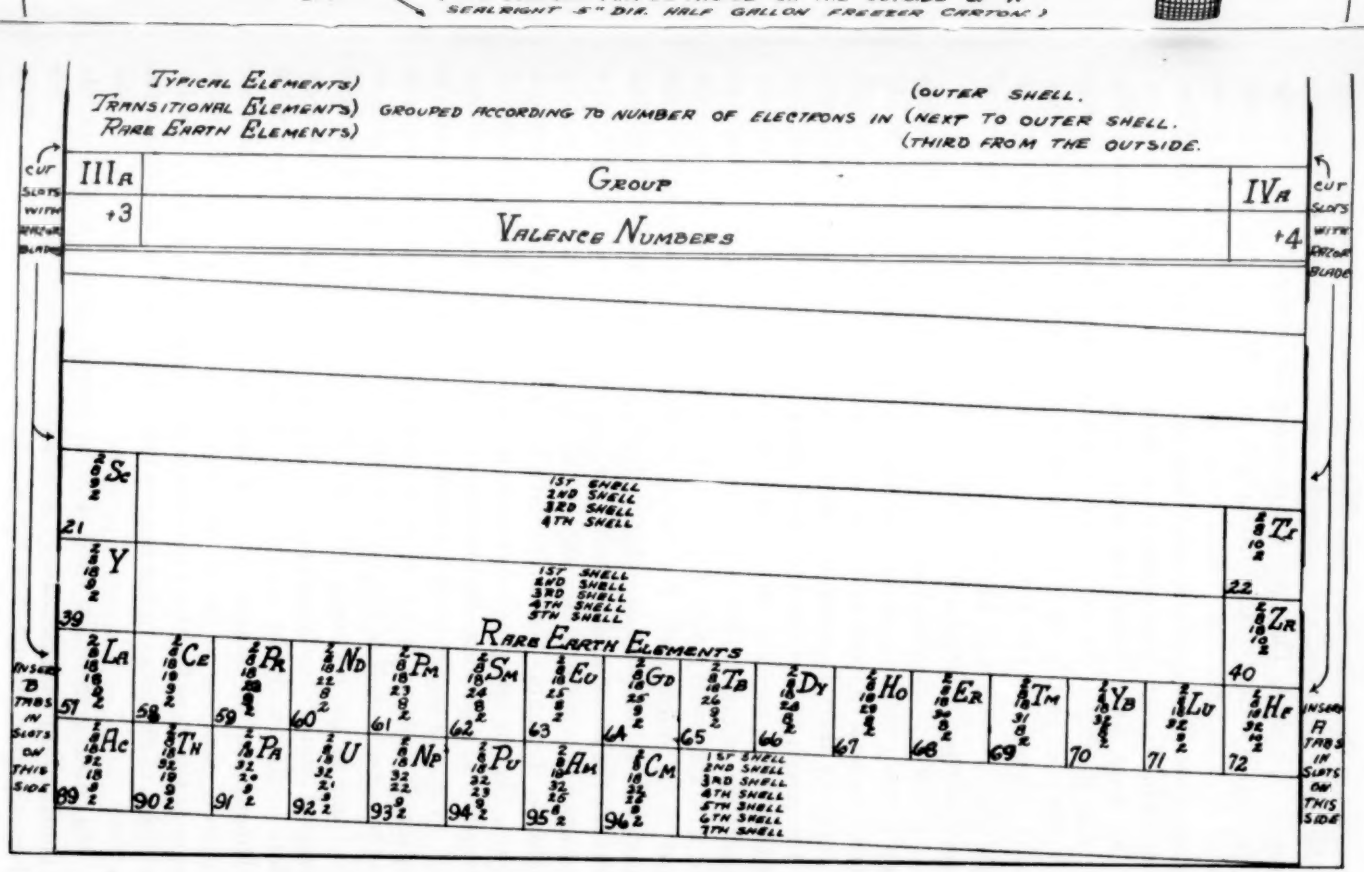


FIG. 4. Student Model of Spiral Periodic Chart.

electrons in the outer shell and nine to eighteen electrons in the next to the outer shell and are grouped according to the number of electrons in this shell. They are the elements in which this next to the outer shell is being built up from eight to eighteen electrons. Periods 4 and 5 each have ten Transitional Elements while period 6 has twenty-four. Period 7 is incomplete with only eight Transitional Elements which have been reported to date.

The Rare Earth Elements have in general two electrons in the outer shell, nine in the next to the outer shell and nineteen to thirty-two electrons in the third shell from the outside. They are the elements in which the third shell from the outside is being built up from eighteen to thirty-two electrons. In period 6 there are fourteen of these elements while in period 7, seven have been reported.

In order to understand the chart it may be well to take an imaginary journey down the spiral, beginning at the top. In the first twenty elements, each element differs from the one preceding by one electron in its outer shell. In passing from element to element along this part of the spiral, we see the first shell being built up to its maximum of two electrons, then the second and third shells being built up to their maximums of eight electrons. Then the fourth shell begins to build up but with the twenty-first element the additional electron goes into the next to the outer shell. For the next nine elements this next to the outside shell builds up to eighteen electrons. Then with the thirty-first element the additional electron goes into the outside shell beginning a sequence of eighteen elements which is like that of the preceding eighteen elements. The forty-ninth element starts a sequence which begins like the two previous eighteen classes but with the fifty-eighth element the additional electron goes into the third shell from the outside to start a sequence of elements in which the third shell from the outside is built up to 32. With the seventy-second element the next to the outside shell continues to build up until it is complete with 18 electrons in the eightieth element. Beginning with the eighty-first element another thirty-two element sequence is begun which is incomplete ending with the ninety-sixth element. Thus the Transitional Elements can be thought of as an interruption in the successive addition of electrons in the outside shell of the later periods. In a like manner the Rare Earth Elements are an interruption in the successive addition of electrons in the next to the outside shell in the 32 element periods.

This arrangement fits each element from hydrogen to curium into a continuous plan yet in a way in which the elements fall logically into three separate groups. The Typical Elements form the "front" of the periodic table. This part of the chart shows the relations among these elements in a clear way without the complications of the other two

groups. The Transitional Elements are considered as having two electrons in the outer shell and as a result are all much alike. The Rare Earth Elements are represented as having the same structure in the two outer most shells and therefore are very much alike chemically.

This chart at first sight may seem more complex but it is actually more simple. Experience has shown that students who have had no previous knowledge of the other charts find the space form more simple, at least, when they have the student model to use in their study. Invariably students are much better satisfied with it than with other charts.

The advantages of this chart are: (1) its simplicity (2) its separation of the main group (Typical) elements from the subgroup (Transitional) elements (3) its representation of hydrogen as a halogen (4) its emphasis on continuity (5) its regular provision for the Rare Earth Elements (6) its presentation of the arrangement of the electrons in successive shells and (7) its location of the inert gases in the middle of the elements that show a close relationship to them.

EFFICIENCY AND RELATIVE COST OF GAS AND ELECTRIC HEATING APPLIANCES

H. Clyde Krenerick
Milwaukee, Wis.

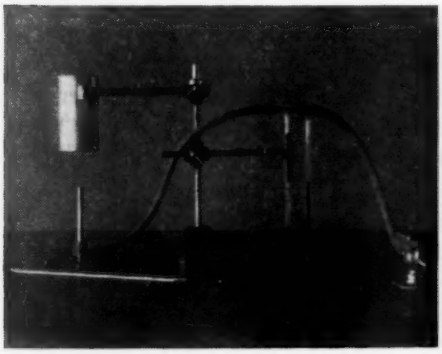
To determine the efficiency of a gas stove and the efficiency of an electric stove are two interesting experiments. To be able to compute the cost of a certain amount of heat (1000 B.t.u.) with each stove and determine the relative cost of operating gas and electrical appliances makes the experiment doubly interesting and instructive. It is especially gratifying when they can be done without any expensive or special equipment. All of the pieces may be found in the average laboratory.

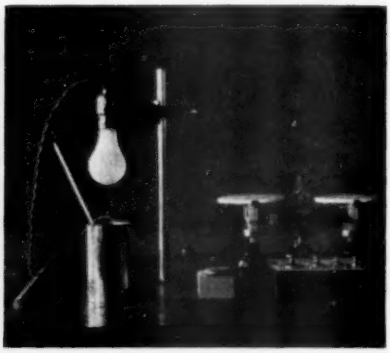
If the efficiency or the cost of operating a gas stove is to be determined, the amount of gas used must be measured. The standard meter, the Thorp Gage, is very expensive and individual work in most schools would be impossible. With the above apparatus each student may have his own measuring device as it consists, only, of a T-tube and an open water manometer. The difference of the water levels or the manometer reading will depend upon the rate of flow of the gas.

The student is informed in the instructions at what difference of levels the manometer must be adjusted to have a certain rate of flow of gas. The difference of levels to be used depends on the type of

burner or stove tested. It would need to be determined by previous tests if types other than those shown or described in the instructions were used.

The output for computing the efficiency is determined from the weight and temperature change of the water used. To compute the input obtain the fuel value, number of B.t.u. per cubic foot, of the gas from the local gas company. A practical part of the experiment might be to determine, if high or low flame has an effect on the efficiency or if there is any advantage in using a high flame when cooking vegetables.





An electric lamp placed in water in a metal vessel is an electric heater or stove. It is an electric heating element in contact or inclosed within the substance to be heated. No A.C. meters are required as the wattage is given on the lamp. The input is obtained from the relation, one B.t.u. is equivalent to 1055 watt-seconds. From the local cost of electrical energy per kilowatt-hour, the cost of 1000 B.t.u. may be computed.

This article with its illustrations is a part of a number presented at the Physics Section of the Central Association, "Research in the Teaching of Physics." Other parts of the number may be found in the June and December issues of SCHOOL SCIENCE AND MATHEMATICS. The author's twenty-five years of research in methods and materials for teaching physics has developed many new experiments and a large number of new designs in apparatus. These may be found in the new laboratory manual *Experiential Physics*. See its advertisement on page vi of this issue.

DEMONSTRATION SHOWS HOW RADAR BOUNCED OFF MOON

How radar rays were bounced off the moon is shown in a Signal Corps exhibit presented to the Smithsonian Institution.

Visitors viewing the display can push a button and set in motion electronic reactions that simulate the actual moon contact, first made Jan. 10, 1946, at the Army Signal Corps Laboratories in New Jersey. This demonstrated that radio waves can slip out through our "radio roof" and get back through the ionized layer high above the earth's surface.

GENERAL MATHEMATICS FOR GRADES 9 TO 12*

W. D. REEVE
Teachers College, Columbia University, New York 27, N. Y.

INTRODUCTION

This discussion is in no sense an attempt to discredit the traditional organization and teaching of mathematics in the secondary school even though the results for most pupils might justify one in attacking traditional practice. I know, as a matter of fact, that, for many pupils and their teachers, the sequence of algebra, geometry, trigonometry, and so on will continue to be that chosen in an appreciable number of schools and often for reasons that may seem valid enough, at least to a great many teachers. If we can agree on that, we may then view honestly and fairly the question as to whether, for large numbers of our pupils, a reorganized course in general mathematics may not be more profitable for all concerned.

In the first place there is no question but that the teaching of algebra, geometry, trigonometry and the other traditional subjects have been improved in many schools. But we all know that there are many teachers all over this country who covet the opportunity to learn better ways of organizing and teaching mathematics by actually trying out certain content materials and then measuring results. I have been one of those who likes to try new ways of organizing and teaching mathematics. To be sure some mistakes will be made, have been made, and later I want to point out some of these. However, there is more hope for the future if qualified teachers operate experimentally to try to find the answers to some of the most pertinent problems rather than to hold fast to the *status quo*.

As I said many years ago[1] the case for general mathematics rests largely on the fact that it gives results that are highly gratifying. This is especially true if the work is continued throughout the secondary school.

The movement for general mathematics is not a new idea. John Perry, many years ago in England, saw the importance of reorganizing content and method. He put the case as follows:

> Great fields of thought are now open which were unknown to the Alexandrian philosophers. If we begin our study as the Alexandrian philosophers did, with their simplest ideas in arithmetic and geometry, we shall get stale before we know much more than they did. If we begin assuming more complex things to be true (although I do not like to assume that in truth any idea is more complex than another) as we have done in arithmetic, as we ought to do in other parts of math-

* Paper read at the General Session of the Central Association of Science and Mathematics Teachers at the Claypool Hotel in Indianapolis, Ind., on Friday Nov. 26, 1948.

[1] Reeve, W. D. "The Case for General Mathematics." *The Mathematics Teacher*, November, 1922. P. 382.

ematics without becoming stale we may know of all the modern discoveries. We shall get the same intellectual training with more knowledge.

He says further:

In these days all men ought to study natural science. Such a study is practicably impossible without a knowledge of higher mathematical methods than that of the mere housekeeper. It must be more than what is called "knowledge," it must be mental dexterity, and it must be kept in constant practice if it is not to become rusty, and if men are to remain unafraid of mathematics. As examples of the methods necessary even in the most elementary study of nature I may mention: the use of logarithms in computation; knowledge of a power to manipulate algebraic formulae; the use of squared paper; the methods of the calculus. Dexterity in all of these is easily learned by all young boys. In such practice their brain power develops quite rapidly and they learn with pleasure. I feel sure that such dexterity cannot hinder, and can only further the mathematical study of the exceptionally clever student.

For an advanced study of natural phenomena we need the results of the best study of the greatest mathematicians. To me mathematics is a powerful weapon with which to unlock the mysteries of nature. If a man knows how to use the weapon, that is enough. Let him leave to others, the men who delight in that, the forging of a weapon, the complete study of it. If I can use the weapon, let my study be of another kind—I think of a higher kind—to study the secrets which even an unskilled use of the weapon will reveal to me.

I have the belief that the study of physical science, and therefore the study of mathematics, by everybody, however poor or however rich, is of the utmost importance to our country, not merely for the knowledge it gives, but for producing the scientific habit of thought, giving to every unit of population a power to think for itself, and so producing the greatest happiness and giving the greatest strength to all kinds of the nation.[2]

My proposal is that wherever the conditions permit we arrange our mathematics so that we shall not have courses in algebra, in geometry, or in trigonometry as such, but a definitely arranged and psychologically ordered course in mathematics. This plan will give the pupil who desires it a six year course in mathematics in the secondary school. At the end of such a course, he will be as well prepared as most college freshmen today if not better. It is also hoped that the course will be more compact, will involve less waste, develop more power, and produce even better results than we have been getting from traditional methods. The content of this course will be arithmetic, algebra, plane and solid geometry, trigonometry, most of the analytic geometry, and the fundamental elements of the calculus.

There is nothing essentially new in the plan of teaching algebra, geometry, and trigonometry, together. The best teaching talent in mathematics the world over, long ago recognized the importance of emphasizing the relation between algebra and geometry and the advisability of teaching them together. The movement to unify the two subjects has been vigorously opposed by those who seriously insist

[2] Perry, John. British Association Report on "THE TEACHING OF MATHEMATICS," pp. 3 to 16. Macmillan, 1901.

See also Breslich, E. R. "Correlation of Mathematical Subjects." SCHOOL SCIENCE AND MATHEMATICS. February, 1920.

that such unification will break up the logically ordered system of Euclidean geometry and give rise to a series of unrelated ideas without unity or natural sequence. But if we are ever to cut the "ancestral process" short enough to enable us to give the boys and girls anything beyond what we ourselves have had, we must omit a great deal that was formerly taught and reorganize what is left in a more psychological way. We can still plan courses in algebra and geometry, as such, for the special needs and the special cases where such procedure seems necessary and wise.

Purpose of a General Mathematics Course

The purpose of a general mathematics course in the secondary school should be to furnish a basis for a modern scholarly course in elementary mathematics that will give such careful training in power and appreciation as well informed citizens of our democracy ought to possess. Moreover, the material should be so arranged that the boy or girl who has to leave school at any time may nevertheless get a better understanding and appreciation of some of the basic ideas.

Present Offering

In the traditional sequence nothing but arithmetic is offered until the ninth year and practically nothing in mathematics is offered in the fourth year of the senior high school. In many schools no mathematics is even offered in the third year. No attempt has been made in such sequences to show how one subject may be made to reinforce and supplement the other. Failure to do this results in waste of time and energy as well so far as the pupil is concerned. A general mathematics course shows more clearly how each subject is reinforced and made clearer and more helpful by the other.

Junior High School Course

The typical modern junior high school, constituting grades 7, 8 and 9, now offers some kind of a general introductory course in mathematics. The content, methods of teaching, and order of presentation of topics may vary from place to place, but the great central purpose is fairly uniform. This type of course should prevail in all seventh, eighth, and ninth grades throughout the country even though the junior high school organization as such is not universally recognized. Everybody who wishes to be educated should know something of the essential applications of arithmetic, of the central features of informal geometry, of the meaning and uses of algebra, of the nature and value of numerical trigonometry, and of the meaning of a demonstration in geometry. The course described above should be required of all pupils

whether they leave school at the end of the ninth grade or go on to the senior high school. In four-year high schools it will be necessary to require some kind of course in the ninth grade that will give the pupils a training that, in the long run, will represent what the educated citizen should know about mathematics as a tool.

The essentials of the junior high school course consist of the following categories:

1. *The fundamental arithmetical skills* with integers and fractions (both common and decimal), with applications of these skills to the problems of daily needs.
2. *Informal geometry* consisting of:
   a. Intuitive geometry—looking at a figure and saying that certain things are so because they could not be otherwise. For example, "If two straight lines intersect, the vertical angles are equal," or "If two sides of a triangle are equal, the angles opposite these sides are equal."
   b. Experimental geometry—cutting out a paper triangle, tearing off the angles and then placing them adjacent to show that their sum is 180°.
   c. Observational geometry—recognizing objects as typifying certain geometric forms and seeing certain relationships and important facts that exist between them; such as, "Any angle inscribed in a semicircle is a right angle," or, "If two parallel lines are cut by a transversal, the alternate angles are equal."
   d. Fundamental geometric constructions—such as drawing perpendiculars, bisecting a line or an angle, and drawing parallel lines.
   e. A simple approach to demonstration—through what is ordinarily called an informal proof. For example, after the student has shown by a simple experiment that the sum of the interior angles of a triangle is 180°, he can then prove informally that the sum of the angles of a quadrilateral is 360°.
3. *The simpler elements of algebra* organized around the formula, the equation, the graph, and directed numbers.
4. *Scale drawings and numerical trigonometry*, the two methods of teaching the student how indirect measurements are made.
5. *A six weeks' unit of demonstrative geometry.*

Ninth Year Course

The organizing and unifying principle of the general mathematics course should be the idea of functional relation—the dependence of one quantity upon another. In the ninth year the function furnishes the central idea of the course and the simpler truths and constructions

of geometry help to rationalize some of the more formal aspects of the algebra and later to furnish exercises for algebraic applications. This is done in various ways, but the function concept, either implicitly or explicitly, dominant throughout, helps to lend concreteness and coherence to the subjects. Excessive formalism is greatly reduced and the emphasis is placed upon the function, the equation, the formula, and the graph. Enough time is saved to permit us to furnish more illustrations and applications of principles and to introduce new and more important material.

Instead of waiting until the tenth year and trying to crowd all of the difficulties of demonstrative geometry into that year, we introduce a great deal of informal geometry in the first year, followed in some cases, by a simple approach to demonstrative geometry only where it comes naturally and easily. In this way many of the relations are taught inductively by experiment and by measurement, to be followed later by more formal proofs. The pupils who have geometry in this way do not start the geometry work in the tenth year as if it were an entirely new subject, as has often been the case. We also bring in arithmetic applications where it seems feasible.

In the next place, our traditional methods have delayed the teaching of much that is interesting and valuable in the secondary field. In this respect many of the English and continental schools of Europe are far in advance of us. The elementary ideas of numerical trigonometry, in many respects very simple, have been omitted altogether from many secondary schools. They are as easy for a ninth grader as anything else, once he understands the nature of similar triangles.

The work in numerical computation keeps the pupil conscious of the fundamental importance of arithmetic in all mathematics work; the work in informal geometry offers the best possible preparation for a unit of demonstrative geometry during the last part of grade 9, or for the geometry work of the tenth grade; and the work in trigonometry which is now being generally included as part of ninth grade algebra, gives the pupil an excellent idea of indirect measurement.[3]

Purpose of Senior High School Mathematics[4]

The purpose of the mathematics course in the senior high school is to meet the needs of the following four groups of pupils:

1. Those who intend to go on to colleges and technical schools.
2. Those who are going to specialize in commercial work that re-

[3] See, *A One-Year Course in General Mathematics for the Ninth Year.* (1936 Edition). The University of the State of New York, Albany.

See also Reeve, W.D. "Curriculum Problems in Junior High School Mathematics." *Teachers College Record.* January, 1928.

[4] Reeve, W. D. "The Mathematics of the Senior High School." *Teachers College Record.* Dec. 1926.

quires mathematics, especially algebra.

3. Those who expect to specialize in science.
4. Those who desire to study mathematics further because they like it.

Because of the purpose outlined above it would seem that the senior high school course in mathematics should be made elective.

Content of the General Mathematics Course

Obviously the content of any course in mathematics should be determined by the purpose in mind. At the present time there is little attempt in most high schools to consider the needs of individual groups like those above, or even of individuals themselves. Indeed, this may continue to be true of the majority of the small high schools of the country.

Geometry is required of nearly everybody, regardless of whether the pupils taking it can all profit by its study. This condition is due almost entirely to the dominance of extramural examination boards who have in mind only the needs of the first group mentioned above. Plane geometry is taught in all schools,—usually in the tenth grade. But beyond that point there is no uniform practice. In some schools intermediate algebra and solid geometry are taught in the eleventh year, in others these subjects may be deferred until the twelfth year. In a few high schools trigonometry and college algebra are offered in either the eleventh or twelfth year, but the number of such schools is very small. Even where such higher courses are offered, the situation results not so much from a desire to meet the needs of any particular group as it does because of the influence of some local teachers. In some cases we have schools in which analytic geometry and calculus[5] are offered.

Tenth Year Course

In the tenth year we take up the more logical and rigorous methods of demonstrative geometry as the central theme, but we keep the algebra before the student constantly by means of algebraic applications. Algebra and trigonometry are used wherever they help to clarify proofs. In addition, we take up many of the facts of solid geometry at the points where their analogy is most natural and easy. We also introduce the pupil to problems connected with "life thinking" after the manner so well developed by Fawcett and described by him in the Thirteenth Yearbook.[6]

The purpose of the geometry course is to show the pupil the meaning

[5] Durst, Ethel H. "Calculus for High Schools." *University High School Journal*, June, 1926.

[6] Fawcett, Harold P. *The Nature of Proof*. The Thirteenth Yearbook of the National Council of Teachers of Mathematics. Now out of print.

of a demonstration, to enable him to have the satisfaction of proving something, to let him see the significance of mathematical precision, and feel the joy that comes from discovering absolute truth. In other words, the work in geometry is the only course in deductive logic which a pupil can get in a secondary school.[7] It is better than pure logic because it has in it figures that illustrate the things that are said and done.[8] If geometry is not taught to give a training in deductive logic, in the power to prove one's own statements, or if it does not do both, then it is not worth teaching.

In view of the pressure of time and the needs of the curriculum, it is clear that we can no longer justify in all schools, separate courses in plane and solid geometry extending over a year and a half. The tendency in many schools at the present time is to devote one year to the study of both and to combine them properly for teaching purposes.

The difficulty with the ordinary geometry course in American high schools is that we have held too strongly to the systematizing motive and have given the pupils an unadulterated form of Euclid. We should profit by the suggestions of The Mathematical Association[9] even though we need not imitate in every detail the practice which its report advocates. The British list is not so long as ours used to be, and it spreads the work out over a longer period of time so that it is better understood. Our course must necessarily be somewhat uniform on account of the mobile character of our population, but it need not be so extensive as formerly.

Number and Importance of Propositions

The results of geometry teaching can be improved by decreasing the number of theorems we teach, by concentrating on those propositions which are unquestionably fundamental, by recognizing the importance of original work, and by emphasizing ability to demonstrate rather than the number of propositions studied and perhaps often memorized. We now expect the pupil to master only about one hundred propositions.[10] One modern text has nearly one thousand original exercises.

We ought to take many theorems for granted. The three on congruence in the early part of the work in geometry should be postulated. Some teachers say that plane geometry cannot be taught in one year. This presupposes a "definite amount of ground" to be covered, which is a myth. We cannot teach all that is known of geometry in many years or even in a lifetime. We must remember that for some pupils a

[7] Carson, G. St. L. *Mathematical Education*. pp. 85–112. Ginn and Co., 1913.
[8] Smith, D. E. *The Teaching of Geometry*. Ginn and Company, 1911.
[9] *The Teaching of Geometry in Schools*. Mathematical Association. G. Bell and Sons, (London), 1923.
[10] *Revised Report on the Requirements in Plane Geometry*. pp. 9–17. College Entrance Examination Board, 1923.

few propositions will suffice while for others the number must be much greater.

The work in trigonometry above that taught in the ninth grade is carried on by giving more advanced problems in the solution of right triangles, some work in proving simple identities, and particularly an introduction to the solution of oblique triangles using the sine and cosine laws. A great deal of emphasis in the tenth year is given to the different methods of attack and habits of studying. The pupil is made familiar with inductive, deductive, analytic, synthetic, and indirect methods of proof. By the end of the year we expect capable pupils to do a high type of work.

Eleventh Year Course

In the eleventh year the geometry is not so prominent and comes in again in the role of a helper to the algebra and trigonometry. The algebra and trigonometry are related within topics as near as possible; e.g., when we are treating algebraic equations in one unknown we treat trigonometric equations in one unknown and try to make clear the likenesses and differences in the nature of the solutions. We have ample opportunity to do a great deal with the simpler elements of analytic geometry without any loss of time so far as we can see. The function is the unifying idea in this year's work.

Plane and Spherical Trigonometry

Trigonometry is strictly a high school subject. Pupils generally like the subject when it is well taught and we have evidence to show that they do as well with it as do college freshmen two years later.

In a study which I carried some years ago, on a group of high school juniors made, on the same series of examinations in trigonometry, a semester average six per cent higher than a freshman class in the University studying the same subject. This does not prove that the high school pupils were better, but it certainly shows that the subject was not too difficult for them.

The fundamental ideas of both plane and spherical trigonometry can easily be covered in a half year's time and for many pupils it need occupy no more than twelve weeks. Many pupils can learn it in much less time. Since, however, the applications of spherical trigonometry are almost entirely confined to astronomy and geodesy, it has limited sanction under our present conditions.

Intermediate Algebra

For those who intend to proceed further in science, economics, mathematics, or other technical subjects, either in college or else-

where, more mathematical work is necessary. The course in intermediate algebra still occupies a large place in many schools and should continue to do so. In some schools it is amplified so as to occupy a year's time; but a half year should be sufficient, especially if needless reviews of the elementary course are omitted and the remainder of the course is modernized. There is the same need now for reform in the content of some of our intermediate algebra courses as there was ten years ago in elementary algebra.

The essence of the course in algebra should be functional relationship,—the notion of the dependence of one quantity upon another. In some schools trigonometry, analytic geometry, and the calculus are introduced at this point to help bring this about. Professor Nunn the well-known English writer, has said:

> As soon as the symbols of trigonometrical ratios are recognized as capable of entering into formulas and of being manipulated, they should be regarded as belonging to the vocabulary of algebra. There is, indeed, no principle except the invalid principle of formal segregation, upon which we can include the study of x or a in the algebra course and exclude sin x or tan x. All alike are pieces of symbolism invented for the description and interpretation of facts of the external world. Each represents a typical kind of function. To each corresponds a specific form of curve which may be regarded as the graphic symbol of the function. Both algebra and trigonometry would gain by fusion,—the former through an added variety and richness in the illustration of its main themes, the latter by the removal of the excessive formalism which at present obscures its value and interest for the beginner.[11]

Twelfth Year Course

The demand for such a course is due to the wide differences that exist today both in the work of the junior high school and in the purposes of instruction in the senior high school. Thus, we find one group of pupils in the four-year high school whose previous work in mathematics has been limited to arithmetic, another whose course may have included general mathematics like that set forth in the first or second book of a modern junior high school series, still another group which may be preparing to go to college or technical schools, and a few others who intend to go into business or enter upon some other career. It would be impossible for the traditional courses of study to meet the needs of all such groups.

In the twelfth year we hope to unify the college algebra and the analytic geometry with some of the elements of the calculus in a better way than we have been able to do it so far by giving the earlier courses more compactness and better treatment. It goes without saying that not every pupil would be expected to study mathematics through the entire secondary school, but it is interesting to note that

[11] Nunn, T. Percy. *The Teaching of Algebra.* (Including Trigonometry). Longmans, Green and Co., London, 1927. Pp. 19–20.

where such opportunity is offered there are always those who are eager to register for the various courses though they are not required.

Methods of Teaching

Our methods of teaching mathematics also need to be improved. The knowledge we now possess of individual differences in ability should make the study of mathematics a kind of laboratory course, in which more effective work can be done because the material can be better fitted to the individuals pupil's needs. Such an arrangement of material decreases the need for so many reviews because each subject is kept in more or less constant use. As a result there is a gain in mathematical power and less need of home study. In the junior high it is even possible to get along with little or no homework.

It is for the class of pupils who love mathematics or show unusual ability in it that I should want especially, to see the opportunity given to go on with their work in such a general course. They are the ones who will be the future teachers or research students in the subject.

Courses for the Colleges

What the colleges might do to adapt their courses to the pupils who finish the kind of course outlined above is largely a problem for the colleges to solve; but there are some things that will add greatly to the chance of an early agreement on a course. In the first place, the secondary school teachers should get together and formulate more definitely than heretofore minimum courses for each year setting up certain standards of attainment. Secondly, the college teachers should familiarize themselves with these courses and, if they are satisfactory, they should build their college courses upon the secondary school courses as far as possible. In this connection, I have never understood why the general mathematics courses in the colleges have not been more successful.[12] Thirdly, we ought to have frequent visitations back and forth wherever possible to enable those on both sides to keep in mind just what is to be expected as a final outcome and how much is being done on each side toward making a proper contribution. Then, if we study our habits, and improve our technique, we shall get results that are worth while and mathematics will maintain the dignity which it has so long held in the curriculum. There has been an enormous lot of time wasted by repetition and so-called reviews that do not deserve the name. And the fact that the college courses do not fit on properly to the secondary school courses has led to a still further loss of many a student's time. Then too, a great many colleges

[12] Brown, Kenneth E. *General Mathematics in American Colleges*. Bureau of Publications, Teachers College, Columbia University, 1943.

and universities fail to provide courses at the proper time for pupils who are ready and eager to go on and often loss of time and gaps in instruction appear. It will be argued, of course, that proper adjustments are impossible because of administrative difficulties, but it is not hard to conceive of a little better situation than we often find.

What the New Mathematics Should Be

H. G. Wells in *Mankind in the Making* said:

> The new mathematics is a sort of supplement to language, affording a means of expression, more exact, compact, and ready than ordinary language. The great body of physical science, a great deal of the essential facts of financial science and endless social and political problems are only accessible and only thinkable to those who have had a sound training in mathematical analysis, and the time may not be far remote when it will be understood that for complete initiation as an efficient citizen of one of the great new complex world-wide states that are now developing it is as necessary to be able to compute, to think in averages and maxima and minima as it is now to be able to read and write.

While to those who have given the subject no thought this may seem to be a strong statement, the fact is that we are going to discover many more ways to use mathematics profitably in the next generation.

Two unfortunate attitudes have grown up with regard to general mathematics in the secondary school.

1. That general mathematics is a course for dull normals or pupils of low ability to do mathematics.
2. That a one-year course in the ninth grade will serve the purpose for most pupils who take it.

Both of these attitudes are wrong and it is high time we do all that we can to correct them. In the first place it happens that the very nature of a general mathematics course makes it more interesting and in actual practice more easily learned than the traditional algebra course in general mathematics properly organized might also be more interesting and valuable to gifted pupils as well. The trouble is that the feeling that general mathematics is a course for weaklings results in textbooks that do not meet the standards that should be set up for such a course. In the second place we know from careful research that a one-year course in general mathematics, and often this is a terminal course for the pupil, is no better than a course in algebra. However results have shown that a two-year course in general mathematics is the equal if not the superior to a year of algebra followed by a course in geometry for the pupils concerned.[13] Those of us who have taught such courses know that this is true.

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[13] McCormick, Clarence. The Teaching of General Mathematics in the Secondary Schools of the United States. Bureau of Publications, Teachers College, Columbia University, 1929, pp. 32–52.

In a recent article Zant says:[14]

The custom prevalent in many of our high schools of putting the bright students in the algebra class merely because they can learn the traditional courses may not be the best for them or for the school. Such practice tends to cut down the efficiency and standards of the general mathematics course and the sequential courses may not fit the needs of the student unless he expects to study more advanced mathematics or some of the subjects which demand such knowledge. In other words this does not solve the problem. It may merely penalize the bright student simply because he has more than the average intelligence. The thing to do is to strengthen the general mathematics course so that it will actually meet the needs of the non-mathematical scientific student and to point out to the students and to their parents that the course has different purposes or goals. The course should not be for "dumbbells" and, while it may not be as rigorously difficult as algebra or geometry, it can if it is well organized and administered be just as challenging and for many students much more useful.

[14] Zant, James H. "What Are the Needs of the High School Student?" *The Mathematics Teacher*, February, 1949.

FROST WOODS BURIAL MOUNDS

Frost Woods, in the Village of Monona, just outside of Madison, promises to be one of the most outstanding archeological "finds" ever made in Wisconsin.

Within this area, now being developed for a Monona Village park and residential section, are about a dozen Indian burial mounds, believed to be remnants of the ancient Hopewell tribe whose civilization flourished some 10 or 15 centuries ago.

Discovery of the site was made some months age by a road crew cutting through the Frost Woods Heights.

Since then, University of Wisconsin and Beloit College scientists and students have been unearthing skeletal Indian remains in a "remarkably good" state of preservation because of the good drainage from high ground and the protective qualities of clay soil.

Since the beginning of the fall semester, archeologists and students from the University of Wisconsin have uncovered a complete—though in certain respects puzzling—skeleton, a "bundle burial," and a large number of scattered human bones.

"The entire hillside around the single mound incorporated into the city park at Frost Woods is covered by a series of low rounded hills," according to David Baerreis, instructor in anthropology who is directing the excavation. "These hills are not natural, but were constructed, and there are at least a dozen in the subdivision."

Students this fall discovered a complete skeleton of an adult Indian, buried only a foot beneath the surface. "The only feature hard to explain," Baerreis said, "is that the skull was not in the 'normal' position—but beneath the left arm, perhaps indicating a decapitation of some sort."

OLIVES MAKE "MUSHROOMS" WITH NEW RECIPE

Green olives emerge as mushroom sauce when put through an ingenious process developed by the University of California's Division of Food Technology.

The sauce will taste the same and look the same as ordinary mushroom sauce but there won't be a mushroom in it.

Deceptive flavor is obtained by mixing sliced pitted olives, green peppers, salt, garlic, onions, and tomato sauce. The mixture is cooked several minutes before canning. The result: ersatz mushrooms.

THE GREATEST MIRACLE*

JOHN J. MILLER[1]
Director of Clinical Research, J. B. Roerig and Company, Chicago

My ability to walk from my chair to this platform is indeed a great miracle. This is not because I have done the walking, for it would be fully as miraculous for any one of you in this audience to do likewise. The mere act of walking, of balancing oneself while in motion, of starting and stopping the muscular movements involved, are all mysteries of the highest order. And even to you teachers of science it must seem, at least on second thought, that this is a performance which down to date has been beyond our power to explain.

But is it important? I believe that it is, because—like all other body processes—we take them too much for granted. In so doing we fail to ponder each day, as we should, the meaning of the multitudinous reactions involved. We fail to realize what is normal, as distinguished from that which is abnormal. What makes our bodies work harmoniously? What throws them out of gear? Why is one member of a family crippled with arthritis, why is a second member normal, while a third suffers from gastric ulcers or some other dread disease?

Such ailments, together with diabetes, multiple sclerosis, colitis, muscular dystrophy, hypertension and heart diseases, are too common in this supposedly scientific age. Though we may properly boast about the progress of medicine and the general conquering of disease, we often fail to realize that the diseases so conquered are almost altogether of the infectious types. The millions of cases of non-infectious ailments and the suffering which they entail, are apparently a "neglected problem," and it is this to which I wish to call your attention today.

And why this increasingly serious phase of our disease situation has been so long neglected, is, I am sure, a matter of deep concern to you —the educators of the oncoming rulers of society. It is something for you to conjure over, for it is a matter that lies largely within your power to correct. I do not mean by this that you can properly teach medicine or pathology as a part of your school curriculum. What needs to be done is vastly to improve the public understanding of the possibilities and processes of bodily health. We must learn to appreciate that we do not become ill because of a predestination to disease, or because we are victims of the law of mathematical chance, or because of the vengeance of some Deity who is visiting the sins of disease upon

* Read at the Biology Section of the Central Association of Science and Mathematics Teachers at Indianapolis, November 26, 1948.

[1] Former Editor of *Chemical Abstracts*.

the children of the third and fourth generations. Aside from infectious ailments, disease should be looked upon as a *lack* of health. It is a negative condition which can generally be prevented or remedied by seeking the status of complete and positive nutrition. But to acquire and maintain health, we must understand health—which means that we must thoroughly comprehend the many processes of the body—physiological and chemical—which make for normalcy and efficiency in this marvelous organism.

Let me illustrate by considering with you in some detail the wonderful system by which walking is accomplished. The negative picture is the paralytic—the person suffering from such diseases as progressive muscular dystrophy, multiple sclerosis, the various ataxias or the after-effects of polio. The skeletal muscles are not only largely protein in composition, but actually consist in substantial part of a protein enzyme called myosin or actomyosin also, known as adenosinetriphosphatase. Their structure is that of parallel bundles of polypeptide chains joined together with cross linkages of—S—S—groups of cystine or salts of basic and dicarboxylic acid units. These polypeptide chains contract by coiling, and the coiling probably is accomplished by a change in the length of the attached adenosinetriphosphate (ATP) molecule, as it is converted to adenosinediphosphate. Inositoltriphosphate can substitute for ATP. The activators for this reaction are calcium, magnesium and potassium—which must be in proper ratio and position—and the acetylcholine liberated at the neuromuscular junction to start the contraction process. The system sounds quite simple, but there are numerous other factors involved because energy in abundance must be provided for development of muscle power and the by-products of the reactions must be removed from the scene. Otherwise the muscles would soon become poisoned and there could be no further action.

One of these by-products in the skeletal muscles is lactic acid. After strenuous exercise there is an unavoidable accumulation of lactic acid which expresses itself in fatigue. Adequate oxygen in the muscle tissue aids in preventing excess lactic acid and in removing it through oxidation by the enzyme, carboxylase which contains thiamin, and by two other enzymes known as the cozymase and diaphorase systems.

In ways too numerous to mention here the various phases of muscle contraction and removal of by-products are activated or benefited by the presence of practically all the vitamins. It is definitely known, for example, that Vitamins B_1, B_2, B_6, biotin, inositol, choline, and C, E, and K, are all directly concerned in the activity of the many enzymes which make muscular reactions possible. It has been proved, too, that

a deficiency of any one of these vitamins quickly lowers the efficiency of muscle action. For instance, the breakdown of acetylcholine by cholinesterase must be energized by the phosphate energy-rich bonds of ATP, creatine phosphate, or acetylphosphate and the original source of such energy is glucose or glycogen, the utilization of which depends upon the mediation of no less than eleven different enzyme systems—each one of which uses one or more of the vitamins for its work. The blackboard illustration will indicate more graphically how these vitamins function in these vital metabolic processes. Accompanying muscle contraction there is definite loss of glycogen and phosphocreatine, with a gain in lactic acid.

It is quite possible that more than one phosphate molecule is removed from ATP during the contractile process. The first step is the formation of adenosine diphosphate with the loss of the one phosphate and adenosine monophosphate formation as the second phosphate is liberated. During periods of muscle exhaustion the residue is adenylic acid (containing one phosphate). It is probable too, that the removal of the second phosphate from ATP requires a shift in the ratios of potassium, calcium and magnesium, so that potassium may dominate the environment in one step, and calcium or magnesium in the second. Some such shift in electrolytes must be assumed to account for these two steps that are commonly observed. There is little change in or loss of myosin, for one molecule catalyzes the transformation of 30 molecules of ATP.

The processes of relaxation are practically the opposite of those of contraction, but they are generally less well understood. It is certain that oxygen is utilized in abundance for restoration of the dormant muscle state. We have already shown that it aids the removal of lactic acid, which if present in excessive amounts would denaturize the myosin portion of the muscle tissue. Oxygen is also needed for certain of the processes which transform glucose and glycogen into the energy-rich phosphate bonds. Oxygen utilization is improved by insulin. On the other hand an excess of oxygen is harmful—such excess must be offset by carbon dioxide, both in nerve and muscle tissues, and by antioxidants such as Vitamin E. Fatal fatigue is avoided because some substance is formed in muscle as fatigue develops that signals the respiratory center for more oxygen and faster breathing.

The restoration of adenylic acid to the di- and triphosphate states is a complicated mechanism requiring creatine plus phosphate (or creatine phosphate) and the phosphorylases including myokinase, activated by magnesium or manganese. In some way potassium must be driven back into the muscle cells—with sodium taking its place in the extracellular spaces—and acetylcholine, after having been hydro-

lyzed, must be restored by means of the enzyme acetylase, which by the way is activated by pantothenic acid.

Imbalance of these factors in muscle activity causes some form of dystrophy. Aside from the nerve influences, it is established that the potassium content of the dystrophic muscles is low while the sodium content is high. Excess of sodium interferes with the phosphorylation of glucose—thus causing production of unwanted lactic acid. Co-enzyme I and diaphorase help to overcome this condition. Infiltration of fatty substances into muscle fibers is also an accompaniment of muscular dystrophy—accumulations of cholesterol, glycerol and unsaturated fatty acids being noted. This situation may be minimized by adequate Vitamin E or the tocopherols.

In myotonia the muscle is rich in acetylcholine but poor in cholinesterase (7 to 8 times normal amount of acetylcholine and only 1/20 normal of cholinesterase) which means that stimulation of the muscle contraction becomes constant, and there is deficient hydrolysis of the acetylcholine because of lack of cholinesterase. The condition is partially alleviated by Vitamin C, possibly Folic Acid, and other substances which improve the synthesis of cholinesterase. Calcium activates, or is a part of, the cholinesterase system.

Myasthenia gravis is the reverse condition. In this disease there is an excess of cholinesterase and a lack of the synthesis of acetylcholine at the time and place needed. Proper study of the enzyme systems which aid in the formation of acetylcholine at the nerve-muscle junction should point the way to a new approach to the therapy of such distressing ailments. Excessive excretion of creatine in muscular dystrophies is an indication of lack of utilization through failure of its phosphorylation, or use of its phosphate form, rather than a cause of muscular weakness or spasm.

It is apparent then that muscle action is initiated by nerve action; hence the problem becomes "What causes nerve impulse transmission?" At least the nerve impulses from the brain to the extremities! Nerve cells are especially rich in potassium, which remains within the cell walls until activated or released by some outside force. As in the case of muscles, so it is with cholinergic nerves, the mobilization of the potassium is by acetylcholine and the speed of action is at the impressive rate of 480 feet per second.

As potassium is released it greatly increases the permeability of the covering or surface of the nerve fibers and allows some acetylcholine to escape across synaptic junctions or into surrounding tissues. The effects are instantaneous, and in several different directions. One development is the depolarizing of the nerve fiber surface at the point of escape of the first acetylcholine that is formed, and this starts a

wave of depolarizing areas or points along the transmission pathway. The movement of the acetylcholine is like a prairie fire—it feeds on what is before it, for it is synthesized from the materials of the dormant nerve substance and its direction is away from the original initiating stimulus. It cannot escape from its containing surface except as potassium makes that surface permeable. Since that surface is dialectric in character the nerve is short-circuited at the point of passage of the acetylcholine and is reconstituted (or repolarized) again in the nerve tissue area immediately following or adjacent thereto. These processes may be considered the "make and break" of the current set up by the passage of the "wave" due to the constant synthesis and "movement" of acetylcholine along the nerve surface.

But in order that there may be a "wave" of transmission this process must be discontinuous, like an alternating current of electricity. Otherwise there would be a stimulus at only one point on the nerve surface but no transmission of the impulse. The stimulus would be too persistent. It could cause nerve rigor. What is needed is the making and breaking of the acetylcholine effect, and this Nature accomplishes by providing the cholinesterase, called true and pseudo-types, to hydrolyze the acetylcholine into choline and acetic acid, and under normal conditions supplies them in quantities needed for the occasion. These are not the same cholinesterases that are found in the blood or other tissues. They seem rather to be quite specific for hydrolyzing acetylcholine in muscle and nerve fibers, or in the tissues (immediately surrounding the nerves) into which the acetylcholine has penetrated. There one or the other of these esterases attacks and destroys any excess acetylcholine, so that its stimulus will not be continuous.

At this point in the process, potassium which has been liberated across the nerve membrane inhibits any excess action of cholinesterase and then is forced back into the nerve area—possibly by contact with sodium which checks its activity. Thus the original or dormant condition of the nerve has been restored, except for the loss of acetylcholine. However, Nature provides here again by using an enzyme called "acetylase" which catalyzes the synthesis of acetylcholine. The mineral component of this enzyme is magnesium.

In all of this discussion of nerve impulse transmission it should be stressed that the coverings of the nerve fibers must be dialectric in nature, i.e., they must serve as insulating material. In part this purpose is accomplished by the myelin sheath and otherwise by somewhat related fatty substances. It is interesting to note that the myelin sheath is not formed in the unborn babe, but only after a month or more of life. From then on until the child learns to walk its development is rapid, so that as the need arises it becomes available to carry

on its functions of nerve protection and impulse transmission. Phospholipides are the chief constituents of these fatty coverings and these phospholipides are high in inositol. An inositol deficiency, therefore, may induce breaks in the nerve covers or fiber membranes which could short-circuit the impulse transmission system. This is undoubtedly what happens as one of the abnormalities of the body in cases of progressive muscular dystrophy and multiple sclerosis, as well as in amyotrophic lateral sclerosis. These three diseases have this common defect along with some other common denominator deficiencies. Since Vitamin E helps to protect against fatty deterioration in many parts of the body, and since it operates synergistically with inositol, it would seem logical to consider using these two substances in the treatment of these nutritional diseases.

Just as with the problem of muscular activity it is noted that vitamins play important roles, so we can expect the same situation with nerve health and functioning. For instance, thiamin in phosphorylated form aids the synthesis of acetylcholine; Vitamins A, D and K are generally helpful in nerve processes; and riboflavin, pyridoxine, Vitamin C and E, as well as pantothenic acid are specifically so. In fact lack of Vitamin E and pantothenic acid may be directly responsible for much of the degeneration of the myelin sheath.

From the description thus very briefly given of the processes involved in the voluntary movement of a muscle, it must be evident that literally hundreds of detailed reactions are implicated and an equal or greater number of chemical substances produced and utilized. All of these complicated activities take place, moreover, under very carefully controlled yet self-regulated conditions. If the acidity or alkalinity were not correct at any time in any reaction, the transformation might be inhibited or even reversed. If the temperature were not exactly right, we would quickly burn ourselves out or be as sluggish as snails. Moreover, without the proper degree of hydration certainly muscular action would be virtually impossible. Some authors claim that the final or ultimate force which accomplishes the coiling of the muscle is dehydration, with hydration as the relaxing stimulus, and that all the other many chemical changes involved—as described above—are necessary preliminaries to the control of the hydration and dehydration relationships. At any rate, osmosis plays a prominent role in muscular activity—and doubtless also in nerve impulse transmission—so all in all we have to concern ourselves, as we meditate upon the wonders of this bodily mechanism, with forces that are gigantic in power yet infinitesimal in size. Surely we must stand in awe before the wisdom of the Creator who has made man as we find him today.

For a clearer picture of the marvel of this situation, let us consider for a moment what is involved in commercial chemistry in the manufacture of a single substance or basic chemical. Take, for example, the continuous synthesis of a compound as simple as aspirin, which is a combination of acetic and salicylic acids. Even if the starting materials were readily available, it would require expert chemists or chemical engineers months of planning and construction—with other months of designing automatic controls—to produce aspirin by any continuous process on a large scale. Yet it would be still more difficult to manufacture aspirin by a continuous process, where the yields would be in micrograms per second rather than tons per week, even if the entire laboratory were devoted to this one endeavor. Imagine therefore the task which we ask every one of the billions of cells of our neuromuscular systems to assume, when a thousand chemical compounds must be made in less than millionths-of-a-gram quantities, in fractions of a second, and all simultaneously within an enclosure that is microscopic. Let us keep in mind, too, that these thousand compounds must be made to be harmonious in character, as we can be sure they will be, if we provide the body with the kinds of foods which these wonder cells need.

Returning now to the problem of the inception of the force which started the synthesis of the first bit of acetylcholine my body used in beginning the steps to this platform, it is evident that this force must have originated in the brain. The steps involved were not the response to some force outside of the body, but rather the result of a decision made in that part of the mind which reasons or thinks, and as a result establishes conviction. But "How," you will ask, "is it possible that anything as vague and immaterial as a *thought* can produce mechanical action powerful enough to move a 180 pound person across a room?" The recent article in *Science* by Dr. J. L. Kennedy,[2] *et al.*, suggests the explanation, for it shows that the impulse waves of the human mind which arise only from thinking can be measured and their magnitude graphically recorded. This research shows that different degrees of mental performance require corresponding degrees of chemical energy. These thought-impulses therefore develop in the brain tissue, just as the differences of potential develop along the nerve highways. The same ingredients and the same chemical and electrical processes are involved.

Mere thinking, then, develops acetylcholine, and the entire chain of reactions above described for the transmission of nerve impulses

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[2] Kennedy, John L., Robert M. Gottsdanker, John C. Armington, and Florence E. Gray. "A New Electroencephalogram Associated with Thinking," *Science*, Vol. 108, No. 2811, pp. 527–529, Nov. 12, 1948.
Eighty-nine other references were given in this article but are omitted here because of lack of space.—Ed.

and muscular activity are induced to follow in systematic fashion. Reasoning and conviction are therefore the primary forces in the movements of muscles and these mental processes, once they are initiated, have the power to control all the resulting voluntary movements of the body.

But does this explanation really solve the mystery of muscle and nerve action? Or better, does it solve the mystery in a way that will help us prevent or remedy the neuromuscular diseases, such as progressive muscular dystrophy, myasthenia gravis, multiple sclerosis or the after-effects of polio? It may not fully do so, but it will help in a practical way provided we utilize this explanation in our attempts to aid the unfortunate sufferers of these nutritional diseases. To rebuild nerves and myelin sheaths, and to re-educate degenerate muscles, there must be available not only the needed vitamins, minerals, and other essential food factors, but the WILL POWER required to initiate these regenerative chemical processes.

Now, just how WILL POWER in the mind can be converted automatically into chemical potential gradients in the brain tissue, I shall not attempt to say. I only know that there is a definite relationship between these functions, and that somehow they are closely intertwined with a concept which is usually called FAITH. It is this kind of faith that moves mountains!

If time allowed me to depart for a moment from the problem that has so far concerned us, I would dwell on some other phases of this marvelous body of ours. I would mention the intricate mechanisms for controlling body temperatures within the limits of a few degrees, regardless of drastic variations in the temperature of our environments; also the regulation of blood pressures from hour to hour and day to day under the strain of great annoyances; the pH of the blood, which must be regulated to a fraction of a point no matter what the alkalinity or acidity of the food intake; the detoxification of body poisons and a host of other miraculous processes.

Any one of these is just as fascinating and mysterious a topic as is the problem of muscle control, and I am convinced that the proper understanding of how the body works in these matters also will lay the foundation for a new approach to the prevention of such serious ailments as coronary thrombosis, hypertension, diabetes, stomach ulcers and arthritis. None of these conditions should be any more discouraging than the distressing ailments which we class as neuromuscular diseases.

Needless to say, all things in Nature are miraculous, but the greatest of these miracles is not the depth of color of the Grand Canyon, the towering peaks of our snow-capped mountains, or even the starry

firmament of the far-away heavens. The supreme miracle is the one which, unfortunately, we take mostly for granted—the one which is the chief purpose of all creation—the human body!

NEW CORONET FILMS

ENERGY IN OUR RIVERS (One reel, sound, color or black-and-white; Collaborator: Thomas F. Barton, Ph.D., Chairman, Department of Geography and Geology, Southern Illinois Normal University). For centuries the quaint old waterwheel turned a grindstone to sharpen man's tools . . . a millstone to grind his grain. Today massive dams and hydro-electric plants, backed by huge reservoirs of water, furnish electricity to cities and factories . . . furnish water that turns miles of desert into rich farmland. The amazing and wonderful story which lies between these two eras is unfolded in detail here . . . the vital, living story of *Energy In Our Rivers*. (Junior High, Senior High)

WINDS AND THEIR CAUSES (One reel, sound, color or black-and-white; Collaborator: Walter A. Thurber, Ph.D., Professor of Science, State Teachers College, Cortland, New York). Pete's model airplane crashes. He is determined to find out why; so, with Pete, we discover the facts behind thermals, cumulus clouds, and thunderstorms. Then the great winds of the earth are explained . . . on and off-shore breezes . . . the easterlies and westerlies. An excellent introduction to the subject of winds and their causes, so interestingly presented it compels further study. (Junior High, Senior High)

ALGEBRA IN EVERYDAY LIFE (One reel, sound, color or black-and-white; Collaborator: R. Orin Cornett, Ph.D., Vice President, Oklahoma Baptist University). There is nothing mysterious about Algebra. It is only a language of numbers. Students will realize this as they see Grace and Bill solve a problem which confronts them in the preparations for their annual school revue . . . solve it by using Algebra. With emphasis on these three basic algebraic steps: 1) observation, 2) translation, 3) manipulation and computation . . . this film shows how Algebra is used in everyday life as well as in specialized fields. (Junior High, Senior High)

FOUR NEW FILMSTRIPS

EXPLORING THROUGH MAPS is curriculum-keyed for 5th, 6th, and 7th grade Geography and Social Study classes. Dr. Edith Parker, Professor of Geography at the University of Chicago, headed the committee of leading map study experts who prepared this new series of four educational filmstrips.

The first strip in the series, "Maps and Their Meanings," in color, presents basic elements of directions in relation to youngsters' everyday experiences and explains the use of symbols and color as aids in reading maps.

The remaining three strips in the series are black-and-white. "We Live on a Huge Ball" explains the difficult concept of latitude and includes many discussional and "participating" frames.

"Flat Maps of a Round World" clarifies the concept of longitude and presents various types of map projections representing the globe.

"Maps and Men," which reviews the entire series, shows many examples of maps used in business, recreation, travel, the study of history, geography, etc.

Accompanying the four strips in ***Exploring through Maps*** is an illustrated Teaching Guide in which are reproduced all the frames in the series. Guide and strips are packaged together in a study, colorful book-style file box. The entire kit is priced at $16.50. For further information, write Popular Science, Audio-Visual Division, 353 Fourth Ave., New York 10.

BREAKING THROUGH THE BARRIER*

ROBERT D. BECKMAN
Allison Division of General Motors Corporation, Indianapolis, Indiana

Confucius once said, "He who go faster, go farther in shorter time." . . .

The development of civilization has always been linked to man's ability to transport himself and his possessions from one place to another in shorter and shorter periods of time.

It took Columbus 70 days to cross the Atlantic. Now we fly from New York to Lisbon in 14 hours.

A few centuries later, with the application of the wheel to horsepower, a stage-coach would haul you to Chicago in about 2 days. And then if you had been going to the regional cricket matches at the Prairie Club in 1861, you could have taken your first railroad ride to Chicago, and you would have arrived there in 10 hours.

In 1910 you might have been a "Scorcher" in one of the new revolutionary horseless carriages and with plenty of good luck and a minimum number of breakdowns you could have made the same trip in 16 hours.

First direct and regular Airline service was established in 1928, and as a first passenger in a Ryan Monoplane, you would have flown up there in 2 hours.

Now, of course, in 1948, you can fly up in 50 minutes, drive there in $3\frac{1}{2}$ to 4 hours, or take a deluxe train ride in about the same time.

In a manner, science and industry has narrowed the distance between Indianapolis and its nearest metropolis.

Meanwhile everyone has become conscious through press and radio of much higher speeds. You have read—and maybe some of you experienced war time fighter airplane speeds which started out at 350 miles an hour and became 450 before the war ended.

Then last year you read of the new world's speed records of 623.8 mph set by Col. Albert Boyd in an Allison-powered Lockheed P-80 "Shooting Star," followed in quick succession by Navy Commander Turner Caldwell who went 640.7 mph in the Navy's Douglas D-558 "Skystreak," and just one week later in this same plane, on August 25, Major Marion Carl of the Marines made the present world's record of 650.6 mph.

Will I in my lifetime have the opportunity to fly that fast, you ask? The answer depends on your age and inclinations. Whether you will

* Read at the Physics Section Meeting of the Central Association of Science and Mathematics Teachers at Indianapolis November 26, 1948.

or will not, speed has probably caused more changes in our economic life than any other one thing.

In 20 years the average speed of regularly scheduled airline service between Indianapolis and Chicago has been increased 140% from 100 mph to 240 mph. In 10 years this might be increased another 100% to 500 mph through the use of jet engines.

Another question has bobbed up in the public eye recently and that involves man's ability to fly in a piloted airplane at a speed faster than the rate at which my voice is travelling in this room.

We all know that experiments are taking place every day seeking to find if it is possible for man to achieve in flight a speed equal to or faster than the speed of my voice—the speed of sound. . . .

At present we have four airplanes—either built or under development—for the purpose of super-sonic flight test. They are: The Bell XS-1 and 2; Douglas XS-3 and Northrop XS-4.

Now, with our efforts to find out about what happens to pilot and airplane travelling faster than the speed of sound, some new terms have come out of the engineer's lingo into popular vocabularies.

For instance, it no longer is possible to accurately describe the speed of an airplane in terms of miles per hour, because of discrepancies at different altitudes and at different temperatures. A speed of 650 mph at sea level is one thing and 650 mph at 35,000 feet means something entirely different. I was surprised to notice in *Time* Magazine recently, reference to the term "Mach" number. You have all heard or seen the term, but how many here feel they really know what is meant by Mach or the Mach number of an airplane.

Some do, and some do not, so to make sure all of us are on the same wave length, let me try and describe it for you briefly.

All of you realize that the air we breathe, although colorless and odorless (unless we are near a garbage dump) is a substance with weight and mass. But its weight and mass are not uniform. . . . The air closest to the ground is heavier or more dense and hotter because of the weight of the air on top of it that is weighing on it, making it more dense and heavier and hotter. . . . Going up the altitude scale, the air becomes less and less heavy and cooler because there is less and less air piled on top of it. . . . So we can visualize the air about us as being in the form of layers, each one lighter and cooler than the other.

Seventy-three years ago a German ballistics expert, Ernst Mach, while working on the speed of bullets, devised the Mach number to designate speeds relative to the speed of sound. He pointed out that this condition had an influence on the speed of sound and that whereas the sound of my voice in this room—at sea level or close to it, is travelling at the rate of 761 mph—at 40,000 feet and above, the

speed of sound is only 663 miles an hour. Between sea level and 40,000 feet the speed of sound varies as in this curve. Therefore, a new description of speed has been worked out in terms of Mach numbers to give effect to the altitude and temperature at which the airplane is flying.

The super-sonic area is where our scientific interest now lies. This is the area of the great unknown, actually an unexplored frontier.

Once more our scientific progress has brought us up to a point where, like Columbus, we are embarking on a new voyage without charts, without maps or previous experience. Therefore, the scientific approach tells us to find out about the knowns and then venture slowly and painstakingly into the unknowns, benefiting by each new experience.

Here is where the importance of last summer's speed records comes in. True, as a sports loving nation, we appreciate the value of holding a world's record in speed—as we do in any of the athletic competitions . . . . But there is a more serious scientific value to these speed records because in flying at 650 miles an hour, we are in what is known as the sub-sonic region which provides us with experience necessary to safeguard plane and pilot flying in the trans-sonic and super-sonic regions.

So now we have reached the threshold of sonic flight. We have talked in terms of unknowns and of perils to pilot and plane. But what have we learned thus far about these new forces which may lie beyond the sonic wall?

There has, of course, always been some barrier to flying speed. In the past it was because our engines and propellers were not powerful enough to pull us through the enormous air resistance which is built up in high speed flight.

This new speed barrier is not imposed by any sort of weakness of the airplane . . . but by the very nature of the air. The old speed limitations have been overcome—principally through turbine engines which give us the necessary power-plus. In addition we have learned more about aerodynamics and how to design our airplanes to make them streamlined so they can slip through the air with less turbulence. We haven't learned quite enough yet to overcome this new barrier which is called compressibility.

This occurs when the speed of the airplane reaches a point where it no longer slices through the air with the air flowing along the external surfaces of the airplane in a smooth pattern. Instead, the air piles up in front of the airplane and literally bounces off at oblique angles. You have all seen this phenomenon in a boat which gently parts the water at low speeds, but which bounces against it at high

speed. I dare say all of you are familiar with the slamming both you and the boat receive when your boat is trying to cut through the water faster than the composition of the water wants the boat to travel. Water which cannot get out of the way is thrown upward from the surface. This is exactly what happens when an airplane flies faster than the air about it wants the airplane to fly. In air, however, there is no such upper surface and no place for the bow wave to go. Therefore it must be dragged along by brute force.

Shock waves batter and try to twist and rend the plane.

If an airplane actually flew faster than sound, it would, of course, outrun its own noise. You would then see it pass over first and hear it approach afterward. This would be amazing, but it is not the problem. Sound, as such has nothing to do with flight. Sound is simply a series of air pressure waves travelling through the air and hitting the eardrums. Speed of sound is a short expression for "Speed at which pressure waves travel through the air"—and this speed is the same for any kind of air pressure wave, whether it be a loud sound or a soft one, a high one or a low one, a blast wave from an explosion or perhaps the waves you hear when a tire blows out. The only variables affecting the speed of sound are the density and temperature of the atmosphere.

Although sound travels much faster in water than in air, pressure waves in water can be seen. When you throw a small pebble into the water you immediately see pressure waves moving away from the spot where the pebble entered the water. These move at a constant set speed, and the same thing happens in the air when you throw or propel any object through it.

Now let's see how all of this affects an airplane as it travels through the air. . . .

When an airplane flies it displaces a certain amount of air, and in doing so, pressure waves are thrown forward by the leading edges of the wings and by other frontal sections of the airplane. Let's call this a telegraphing system. . . . Molecules of air rush ahead and tap the molecules ahead on the shoulder and say "Start moving out of the way, something is coming." You have all driven through a snow storm and if you will remember, as you look out ahead, the snowflakes start moving out of the way of the car quite a distance before the car reaches them. This run-ahead of pressures and suctions in front of the flying airplane takes place at the same speed at which sound or pressure waves always travel . . . 761 mph in 59 degree sea level air. If the airplane is an airliner cruising at 180 mph, the run-ahead of pressures is way out in front, so the air ahead of the airplane has plenty of time to start flowing out of the way before the airplane

arrives. If the airplane is a fighter travelling at 500 to 600 mph the plane is right on the heels of the pressure waves which always travel at the speed of sound. The air has much less time to start flowing, because the airplane follows right on the heels of the advancing pressure waves. . . . Now if an airplane should fly faster than sound, it would not only outrun its own noise, but would equally outrun its own advance telegraphing system. Its wings would thus smash into air completely unprepared for its impact—air which has not had time to move out of the way. Furthermore, the air will no longer close in at the rear end of the object which accounts for the fact that a bullet does not need a streamlined tail.

Another natural barrier must be overcome before the speed of the airplane reaches the speed of sound. Let's describe this one as "shock" or a "Shock Stall." Briefly this shock begins at a Mach Number of 0.8 to 0.9 depending on the design of present planes, and can best be described in this way . . . . Picture a choppy ocean, with sharp, fairly high waves. A flying fish is swimming at fairly high speed in the solid water below, then all of a sudden he speeds up and begins to leave the water. He can't leave it all at once, for at the surface he hits the air, then goes through a wave, then air. First air hits him on both sides, then water, then air pushes him from the top and water from the bottom, the results being that in the short time it takes him to leave the water and reach the air he goes through considerable shocking circumstances, and he must be strong enough to weather the storm until he breaks through on the top side. Once he is in the air he has smooth sailing; however, he must take the same beating when he returns to the water.

In travelling through the trans-sonic region a plane goes through much the same sensations. Due to the shape of an airfoil, air travels much faster over the top than the air underneath. This is what gives a wing lift, for pressure is lower on top than on the bottom. Just before the speed of sound is reached, even though the plane is flying at less than the speed of sound, the airflow over the top of the wing begins to exceed the speed of sound. The result is that on the top of the wing part of the air is travelling under the speed of sound and some of it is traveling faster, and then slower again, creating such conflicting pressures that they pile up on the wing and form a shock wave which stands still upon the wing. When this occurs the entire lift action of the wing breaks down. The airplane wants to nose down, and at the same time, the tail wants to go up. As a result the airplane "tucks under," becomes uncontrollably nose heavy, steepens its dive and thereby picks up more speed into a straight-down plunge into the ground.

So now—there are a lot of problems to lick before we actually know how to shove through these barriers, but they are not insurmountable problems, and even today they are being taken care of.

How are they being taken care of? What kind of an aerodynamic shape will result? Well, that is not completely learned as yet; however, it is believed that airplanes may have sharply pointed noses, blunt, cut-off tails—like bullets. Wings may be extremely thin, for we all know that we can cut butter easier with the edge of a knife rather than the side, or that an axe cuts wood better with the sharp edge, than the blunt end . . . . The problem is to make them as thin as possible, and still contain the necessary structure to keep them stiff and strong. This may mean much shorter wings, or wings which are swept back.

While we're at it, let's take a good look at some power plants. . . .

It is plain to see that Jet engines have advanced tremendously in a few years of development.

The centrifugal type turbo-jet engine was brought to this country for development from England in 1941, at which time it had a very low power rating and was doing well if it would run several hours on a test stand without failing.

When Allison took over development and manufacturing responsibility for the centrifugal type J33 turbo-jet engine in 1945, it had a rating of 3750 lbs. thrust at sea level, weight 1960 lbs, and we were lucky if the engine would last 45 hours on the test stands.

In a short 3 years this engine has been developed to a point where it is rated at 4600 lbs. thrust, weighs only 1700 lbs. and has a dependable life of 200 hours.

When the F-80 "Shooting Star" broke the world's speed record at a speed of 623.8 mph. this engine developed a maximum of 10,000 horsepower.

Looking ahead, engineers can visualize a maximum output for this type engine of 9000 lbs. thrust, which in a plane travelling 700 to 750 mph would develop about 19,000 horsepower.

These powers will take us through the trans-sonic region. However, even greater power will be required to pierce the super-sonic barrier which will bring into use the ram-jet engines, which will give us speeds up to 1500 mph, rocket type jet engines for speeds over 1500 mph, or a combination of one or more of these with the turbo-jet or prop-jet engines.

Now we come to a question which is probably in all of your minds . . . . What about the pilot . . . how can he stand these high speeds, and what has to be done to protect him? . . .

In going through various maneuvers at high speed the pilot's head

and ears are slammed from side to side and against the rear bulkhead. To protect him, a new energy absorbing helmet that contains a thick layer of cellular cellulose acetate has been designed.

The cockpit, of course, must be pressurized and air conditioned for high altitudes, and refrigerating units will have to be installed to keep the pilot cool. A jet plane flying at 600 miles an hour becomes 60 degrees hotter inside the cockpit than the outside air. At 800 miles an hour, the friction heat increases an extra 115 degrees and at 1000 miles an hour it would be 160 degrees hotter in the plane than outside. This heat is the result both of friction on the plane's surface and the speed at which air is scooped into the ram ducts.

Recently a pilot making a low altitude training run in the Navy's "Skystreak" found his controls had become so hot he could hardly touch them. The temperature had climbed to 170 degrees because he had accidentally switched off the air conditioner.

Speaking of the "Skystreak," just imagine a pilot trying to bail out at over 660 miles an hour. At extremely high altitude he couldn't possibly get out of the plane, and if he could, his body would explode from the quick change of pressure and from the terrific speed of his body. Engineers have thought of all of this too . . . . So . . . if the pilot finds he must abandon the airplane, he trips a lever which allows the pressurized atmosphere in the cockpit to escape slowly, pushes another lever which breaks the entire nose section away from the rest of the plane, and when this section slows down to a safe speed, and the pressure differential is not so great, he is ejected by a special ejector seat which throws him out at a rate of 60 feet per second, and he then descends by parachute.

In view of recent remarkable advances in science and technology, it is clear that any future menace to America must come through the air, with guided missiles and piloted aircraft carrying atomic bombs at super-sonic speeds in the stratosphere.

There is nothing more vital to our national security, therefore, than relentless prosecution of aeronautical research to keep America first in the air. In keeping America first in the air it is absolutely necessary that we learn first how to handle these super-sonic speeds, so we as the defender can protect our own nation from attack against any kind of aggression.

So— When we travel by jet, an impression we'll get,
That things are decidedly humming.
As we're faster than sound, we'll land on the ground,
And listen and hear ourselves coming.

The science teachers are the only people prepared to find and gide the young scientist. Let's give them time to do it.—JAMES F. SEARS, Evansville College.

CHINA TODAY*

FLOY HURLBUT
Ball State Teachers College, Muncie, Indiana

A three-months visit in China one year ago, has left vivid impressions on my mind. An airplane trip from Minneapolis to Shanghai of forty-five hours, including stop-overs, was the first rather startling experience. I had made the trip by water several times, and it always involved two or three days by train to the west coast, a couple of days wait for sailing time, and from two to three weeks on the broad Pacific. The shortest time from our west coast to Shanghai is still fourteen days, I believe. Pan-American makes the trip in five days, stopping over at night. Being a school teacher and having a limited leave of absence, I decided to try the Northwest Airlines which follows the great circle route, or nearly so, from Minneapolis, via Edmonton, Anchorage, Shemya and Tokyo.

We took off from the big air field in Minneapolis at one-thirty A.M. on a Saturday morning, dropped Sunday from the calendar, and were in Shanghai, through customs, in time for dinner Monday evening, and that, in spite of some delay in Anchorage and again over the Yellow Sea. We had a fire in one of our motors, slowed down to about 150 mph, dropped to just above the water and prepared for a crash landing which, fortunately, we did not have to make. Life belts came off when we saw the Yangtze Delta below us, and smiles appeared as our wheels touched the runway on the Lunghwa airport in Shanghai. Customs, passports, medical inspection, etc., took a brief forty-five minutes, in contrast to the hours consumed by steamship passengers in getting clearance.

My first impression was that I must never have been away from China; everything seemed so perfectly natural. The one great change had been transportation time. I could not get over the feeling of having been transported to another world over night.

China is a very different country from the United States, and these differences seemed to me to stand out in greater contrast than twenty years ago. The throngs of people on the streets of Shanghai were as I remembered them. There was the same conglomeration of old and new forms of transportation: automobiles, trucks, buses, street cars, jostling the man-drawn carts, rickshaws, pedicabs (rickshaws drawn by men riding bicycles), bicycles, and pedestrians. There were running water, bath tubs, electric refrigerators and furnaces in some of the homes of the big cities. Although a few modern hotels were in evi-

* Read at the Geography Section of the Central Association of Science and Mathematics Teachers at Indianapolis, November 26, 1948.

dence, much of China has no modern conveniences. In the country one still carries a lantern when going out at night, rides in an ox cart in the North, or in a sedan chair in the South, sees laundry being washed on the stones in the village stream, and two women grinding wheat or rice at the mill by means of two great granite slabs, one placed above the other. Night soil is still gathered every morning, and emptied in great pits to ferment for fertilizer, but public latrines have been concealed behind walls or bamboo screens. Unboiled water is unsafe, and mosquito nets are imperative, unless doors and windows are screened. In spite of more modern equipment, the heating of houses, even those occupied by Americans, has made little progress because of difficulty in getting coal. Coal in Shanghai was $100.00 a ton, United States money, and even in Peiping, nearer the mines, people were keeping houses and classrooms at 55° all winter long. No, China is not modern. I felt sorry, all over again, for our service men who had been stationed in China, and who had no way of learning to know or appreciate the better class of Chinese people. Winter for them must have been bleak, indeed.

The major change in the modernization of China has been the introduction of air transportation into all parts of the country. Shanghai is the hub or center for air transportation, and planes leave Lunghwa Airport several times a week for the North, Central and West, Southwest, and South. I sat for two hours waiting for my plane one morning, and watched planes take off for Peiping, Nanking, Hankow and Chentu, Kunming, and my own departed for Foochow, Swatow, Amoy and Hong Kong. Every plane was crowded, and the airport was thronged with people. The Chinese people were taking to air transportation, as they had to railroad transportation a generation ago. It was amazing, even to me, to see the time saved in a country where old means of travel are still in vogue in rural areas. We did the nine hundred miles to Peiping in three and one half hours, and covered the four hundred fifty miles to Foochow, over mountains almost all the way, in a little over an hour and a half. By boat the latter trip consumes from 36 to 52 hours. By way of contrast, I took one fifteen-mile trip into the interior of South China by sedan chair. It took five hours. Withal, traveling was a queer mixture of the old and the new. Most of the planes were piloted by American fliers. There are two major aviation companies operating out of Shanghai: the China National Aviation Corporation, a Chinese company, and the Civil Aviation Transportation Company, owned and operated by our own retired General Chenault. The former company has a few luxury liners; the latter has the better record for safety.

The waterways of South and Central China are still thronged with

boats, craft of all sorts, from huge sea-worthy junks to sampans (small row boats) and even rat boats on some of the streams with unusually rocky beds.

There were not as many scars of war visible as I had expected to find. Shanghai, now a great city of four and one half millions, showed no evidences of the terrible battles fought there, except in the Chapei area and in the former manufacturing area across the Whangpo River from the Bund. The streets were thronged with pedestrians and wheeled vehicles of all sorts a year ago. Stores and shops were well stocked, but prices were high.

In Nanking, people were still repairing the ravages of war. Two features seemed to be permanent: a Shinto Shrine on a wooded hill in the city, built by the Japanese, and a look-out tower on the highest of the residences on the Ginling College Campus, from which all of the surrounding country can be viewed. A Chinese woman guide showed me a huge image of the Goddess of Mercy in one of the temples. I commented that it was lovely, and she said, "Oh, no! This is a cheap Japanese image. They removed the beautiful alabaster Goddess of Mercy to Japan." In Peiping, there was almost no destruction of property. The school buildings, used by the Japanese, had been reconditioned and many of the unsightly buildings erected by them had been torn down. A few of the latter on the Yenching College campus were being retained and were in use, but they marred the beauty of an otherwise harmonious campus.

Foochow seemed to have suffered more than some of the other areas. Many beautiful old trees had been cut down, leaving the city and country-side with a bare appearance. Shells of buildings still stood, some of them gutted by fire, others made useless by the removal of every stick of wood which could be pried loose.

The most evident effect of war was on the people, themselves. I was told that they were better dressed than two or three years ago when many of them were wearing old American clothing—army and navy cast offs, women's coats, sweaters and even dresses. Last autumn they were wearing Chinese clothes, as usual, although many of them were made over from garments which were gifts from America. The women in Shanghai seemed greatly delighted with new material for warm winter garments distributed by the Moore Memorial Institutional Church of that city.

The food supply was limited. It seemed to me that seventy-five per cent of the people were undernourished. They were still serving feasts, but they were limited by law to a certain number of courses and inferior in quality to feasts of the more prosperous days. The food in Peiping seemed to be better than that in the South, strangely.

The South has always been the more prosperous region. Evidently it has not recovered from the drainage of all available food supplies by the Japanese. The feeding stations, where children were being fed a cup of milk (klim) a day, seemed to be a great boon to the on-coming generation. The Chinese have never made much use of dairy products, but the gain in weight by the children as a result of the additional diet was almost phenomenal. There was hunger, even starvation, in parts of the South during last winter. The hunger riots of recent days in the cities of Central China seemed to be the result of poor distribution. They have subsided since the introduction of rationing.

Hunger was not the only problem. Many people in North and Central China were cold. The Chinese never use much heat in their homes, but there has been almost no fuel since the war, in spite of China's great supply of coal in Shansi. Many furnaces were idle, and people were using small kerosene stoves. Even the big modern hotels were cold. In Peiping the Yenching faculty members said that they were keeping homes and classrooms at a temperature that could not be maintained during the winter of 1946–1947 (55°). One professor's wife, who returned to Peiping at the beginning of the cold weather in 1946, said, "It was a grim winter."

Politically, China has changed. The so-called civil war is making headlines today, but some of the underlying changes and causes struck me very forcibly. First, the old order is gone, dead. I spent October tenth, known as the Double Tenth, the Chinese Fourth of July, in Peiping. Everyone was in a holiday mood, and students from kindergarten through college were out on sight-seeing trips, picnics, pleasure trips and the like. At the Temple of Heaven huge crowds of people, young and old, were gathered. A few students were playing catch on the Altar of Heaven, the pure white altar which only the emperor could ascend, and others marched across the grounds singing in English, "The More We Get Together, The Happier Are We." The Forbidden City, former home of the Imperial Family, was beautiful with its roofs of gold-colored tile sparkling in the sunlight. Today it is a museum, only. Anyone can go through it for a nominal fee. The Summer Palace, built by the Empress Dowager at the foot of the Western Hills, is also a museum and a recreation center. The Western Hills, open to the pleasure seekers for the first time since the war, were attracting many people. The Jade Pagoda and the Marco Polo Bridge, now repaired, also were centers of interest to many sight-seers. The significance of these buildings is gone. Today they stand only as monuments of the past, relics of a by-gone culture.

Another thing which impressed me, when I read the headlines of a Peiping morning newspaper, "Chinese Republic established thirty-

six years ago today," was the startling realization that China, as a republic is very young. I looked up a little Chinese history, just to be sure. I found that for two hundred sixty-seven years prior to the 1911 revolution, China was ruled by the Manchus. All official positions, including provincial and city offices, were in the hands of the Manchus. When the Chinese assumed responsibility for their own government thirty-seven years ago, they had had no experience and almost no training in governmental affairs. They had previously drawn their government officials from the student class—men who had training in the Chinese classics only. There were almost no young people in China with modern training. The first Boxer Indemnity students came to the United States about 1910, and the present colleges and universities in China were just getting under way at that time. During the past thirty-seven or thirty-eight years a surprisingly large number of young people have had modern educational advantages, both in China and abroad.

There has been much criticism of China in our press during and since the war, largely because we have tried to judge China by our standards. That is hardly fair. Historians tell us that it takes time to develop a new order after an old order has been destroyed. Chiang Kai Shek is a military man and a dictator, and his government does have corruption in it. On-the-spot observers tell us he is the only individual holding China together at the moment, and he is doing it by the sheer force of his personality. Perhaps there is no more corruption in China than in our own country, if the truth were known. They do it more openly than we do, and without the check of a second party's exposure and criticism. Also, we deplore what is known as "the squeeze," a centuries-old custom in China; but our skirts are not clean. We could hardly uphold the record of some of our UNRRA and CINRA officials in China, if the story were known. Too bad for us to scream so loudly about China doing things of which we are not guiltless.

Today, inflation is one of China's great problems. The value of China's currency was low last autumn—one hundred fifty thousand dollars Chinese to one dollar United States currency a year ago this week. Later it dropped to several million to one. On August nineteenth, last, the old currency was withdrawn and new currency issued, but the new currency held up for only about six weeks. It has deteriorated very rapidly, and rice is the medium of exchange wherever possible. Many people lost their nest egg of savings when a five hundred thousand dollar bill dropped to a few cents in value. One wonders what may be the answer.

At worst, it seemed to me that there were many hopeful signs in

China. There is arising a group of young, alert, eager, essentially honest young people in government, business, and educational circles, which is very heartening. It is true that some of them want to take the easy road, to come to the United States to live, to go to the cities where there are more comforts, to slip out from under hardship and responsibility, but that is not universal, fortunately. Many of them are genuinely interested in the welfare of their own country, and are eager to be of service.

As I left Shanghai for Nanking with only an address in my pocket and no knowledge of either the city of Nanking nor the Manderin dialect spoken there, I wondered vaguely if I would be able to find my way out to my destination. In my compartment on the train was a young Chinese man, a banker from the Bank of China in Nanking. He knew some English and seemed to enjoy making use of it, so we conversed from time to time during the seven hour trip. Finally, he asked where I might be going in Nanking and I gave him the address. He looked at it and said, "Yes, yes, I know where that is" and he wrote out full directions as to how I might reach the place.

As we started to leave the train, however, he turned to me and said, "You follow me." He had a porter at the door of the train to carry my bag, led me down the platform to the gate, where we presented our tickets, then to the stand where I had to show my passport, and finally to the taxi cab stand. After a few minutes of quiet conversation with the cab driver, he turned to me and said, "All right, get in. I will go part way with you and then send you on." In a short time the cab stopped, the banker handed the driver something which I could not see, said a very gracious, "Goodbye" and left me. We drove on and on, and finally arrived at the number which I wanted. As I left the taxi, I asked "How much do I owe you?" The immediate answer was "Sixty-thousand dollars." I replied that I had put my money in my luggage, and would he please come in until I could open it. My hostess waited until I paid the cab driver, and let him go, and then said, "How come? Only sixty thousand dollars? That trip usually costs one hundred thousand." I told her of my banker friend, and his helpfulness, and we decided that he must have given the driver the other forty thousand dollars.

The future of China is theirs—these youth—but they will need moral, and perhaps financial help for a time.

The second battle for Suchow appears to have been won by the Nationalist forces. Both victories seem almost miraculous to one who has followed recent Chinese history. Again, it is heartening to see the Nationalists rally to the defense of their country, after eight years of struggle against Japan and the almost overwhelming problems of the

post war years, with little help from the outside. Without discussing the communist problem in detail, most of the on-the-scene people agree that the Chinese communists have been trained, directed and equipped in so far as possible (this last has been very difficult) from Moscow. One cannot but rejoice that China is maintaining her hold on most of her country until out-side aid may reach her. If China should fall into the hands of the Communists, it means the whole Far East would eventually come under the control of Moscow, including one half of the population of the globe. The northwestern part of Europe, for which we are struggling, is certainly no more important to the future of the world than the Far East with its teeming millions of people and its wealth of undeveloped resources. Unlike many people, I believe the load would not be overwhelming for us. Perhaps a little help given immediately, would save the Far East and ultimately, the world, from communism.

THE QUIZ SECTION

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1. What coefficient of friction must exist for a sprinter to make the 100 yard dash in 10 seconds?
2. At the foot of a plane inclined at an angle β with the horizon a projectile is fired with a velocity V, the angle of projection measured from the horizon being α. Find the range on the inclined plane.
3. In #2, if the shot hits the plane at right angles show that

$$1+2\tan^2\beta=\tan\alpha\tan\beta.$$

4. Find the least energy which will put a shot over a wall a distance R from the gun if the elevation of the wall at the gun emplacement is α.
5. A weight is suspended from a string. Immediately under the weight stands a peg. If now the weight is drawn aside and projected, discover whether it can be made to hit the peg *on its return trip*.

NEW KIND OF OXYGEN IS DISCOVERED

A new kind of oxygen has been manufactured and discovered.

A Princeton University team of scientists, Drs. R. Sherr, H. R. Muether and M. G. White, reported to the American Physical Society meeting here that by flinging the hearts of hydrogen atoms into nitrogen compounds it is possible to create a very short-lived variety of oxygen.

This is the sixth isotope of oxygen to be known. It is oxygen 14, which makes it just the same atomic weight as the commonest sort of nitrogen. Both positrons (positive electrons) and gamma radiation are involved in the decay of the new kind of oxygen, which exists only about 76 seconds before it turns into an excited sort of nitrogen.

The other sorts of oxygen weigh 15, 16, 17, 18 and 19 times that of hydrogen, lightest of the elements, and oxygen 16 is the commonest sort in the air we breathe. Nitrogen 14 is also in the air.

MULTI-SENSORY AIDS IN MATHEMATICS

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What multi-sensory aids to the teaching of mathematics are available in the classrooms of Massachusetts? To what extent are these used? What suggestions and comments do teachers have regarding the use of such aids? To answer these questions, a survey was made in 1947 of the public high schools in Massachusetts. A complete report is on file in the library of the School of Education at Boston University. For the benefit of teachers and administrators throughout the United States interested in the use of multi-sensory aids in teaching mathematics, a brief summary of the highlights is given in this article.

Questionnaires were sent to all 258 public high schools in Massachusetts. The report is based on the 150 which were returned before tabulation began. The questionnaire listed about 40 different aids and asked for information concerning availability, frequency of use, and type of use of these various aids. In the results, aids in the same general classification are treated as a group.

BLACKBOARDS AND BLACKBOARD EQUIPMENT

The majority of schools are well equipped with squared blackboards, blackboard rulers, compasses, protractors, and colored chalk. But approximately 82 percent never use pantographs, and 67 percent never use spherical blackboards.

STILL PICTORIAL MATERIALS

The percentage of schools which never use still pictorial materials in connection with the teaching of mathematics range from 28.7 percent for graphs to 85.4 percent for wall charts. Bulletin boards, graphs, diagrams, and posters are the more common aids on hand in this group, in the order given. Graphs are used more extensively in the teaching of mathematics than any other pictorial material, with approximately one-half of the schools which reported making frequent use of this aid. Bulletin boards, which are on hand in approximately four-fifths of the schools, are never used in the mathematics classrooms or laboratories of one third of the schools.

LABORATORY EQUIPMENT

Table I summarizes the status of laboratory equipment in the schools.

PROJECTION FACILITIES

Approximately half the schools reported that screens and darkening

facilities were not available in mathematics classrooms and laboratories. Some of these schools mentioned having a "visual aids" room which all departments used for the projection of films, lantern slides, film-strips, etc. Others reported that the auditorium is used for this purpose. Only 63.3 per cent of the mathematics classrooms and laboratories are equipped with electrical outlets.

TABLE I. PRESENT STATUS OF MATHEMATICS CLASSROOM AND LABORATORY EQUIPMENT

Equipment	On Hand	Often Used	Seldom Used	Never Used
Calculating Machines	12.7	5.3	5.3	89.3
Filing Cabinets	22.7	16.0	3.3	80.7
Exhibit Cases	9.3	5.3	2.7	92.0
Solid Geometry Models	75.3	61.3	12.7	26.0
Slide Rules (Demonstration)	37.3	26.0	11.3	62.7
Slide Rules (Small)	64.7	38.7	22.0	39.3
Book Cases and Shelves	60.0	38.7	12.7	48.7
Mathematics Books Other Than Regular Texts	82.0	42.7	37.3	20.0

PROJECTION EQUIPMENT

The majority of schools appear well equipped as concerns sound film projectors, with 71.3 percent, or 107 schools out of 150, reporting this aid available either in the classroom or in the school. Twenty-eight percent of the schools have opaque projectors, and 48 percent have lantern slide projectors.

TABLE II. STATUS OF PROJECTED AIDS AND STEREOGRAPHS

	A	B	C	D	E
Lantern Slides	.7	20.7	7.3	71.3	13.3
Sound Films	.0	11.3	9.3	79.3	27.3
Silent Films	.0	5.3	8.0	86.7	20.0
Film Strips	.7	6.7	6.7	86.0	28.7
Stereographs	3.7	2.0	2.0	92.7	12.0

A: Available in room at all times.
B: Available in school upon request.
C: Available in school system upon requisition.
D: Not available.
E: Should like to have the aid available.

PROJECTED AIDS AND STEREOGRAPHS

The present status of projected aids is such that films, film-strips, and lantern slides are not available in approximately nine out of every ten schools. Of those schools which do not have these aids,

approximately two-thirds indicate no desire to have these aids available. A summary of teacher comments indicates that some teachers are deterred in the use of these aids by lack of time, lack of money, lack of facilities for projection, lack of information, and skepticism as to the benefits to be derived.

Table II summarizes the status of these aids.

Activities

An attempt was made to answer two questions: (1) To what extent are the activities listed used in connection with different mathematical subjects? (2) Are these activities extra-curricular only, regularly or sometimes required, encouraged but not required, or not engaged in because of lack of time?

The following table shows the use of activities.

Table III: Percentage of schools using various activities in connection with different mathematical subjects and how they are used.

Table III

Activities	A	B	C	D	E	F	G	H	I	J
School Journeys	4.7	2.7	2.0	3.3	2.7	11.3	.0	1.3	10.0	28.4
Construction of Models In and Out of Class	4.0	3.3	18.7	46.7	9.3	4.0	23.3	14.7	21.3	12.0
Planning and Working on Mathematics Exhibits	6.7	8.7	8.7	7.3	7.3	5.3	3.3	8.7	9.3	28.7
Mathematical Games and Contents	11.3	18.7	10.7	4.0	4.0	5.3	2.0	14.0	8.0	24.7
Mathematical Plays and Dramas	1.3	2.0	2.0	.7	1.3	5.3	.0	3.3	3.3	33.3
Mathematical Recreations and Amusements	6.0	12.7	10.7	5.3	6.7	8.0	.7	8.0	16.0	21.3
Mathematics Clubs	2.0	8.7	2.7	4.0	6.0	11.3	.7	2.0	8.0	30.7

A: Arithmetic.
B: Algebra.
C: Plane Geometry.
D: Solid Geometry.
E: Trigonometry

F: Extra-curricular only.
G: Regularly required.
H: Sometimes required.
I: Encouraged but not required.
J: No time for it at all.

Comments from Teachers

Comments which accompanied completed questionnaires were interesting and revealed whether mathematics teachers feel multisensory aids are valuable, and the reasons why these aids are not used more. Most comments were on the subject of films. They ranged from extreme skepticism as to their value to enthusiastic support for their use. It might be worthwhile to discuss some of these comments and attempt to answer them.

One school mentioned that most of the films reviewed by its mathematics department showed processes which could be duplicated at the blackboard. If such is the case, the benefit to be derived from those films would not warrant the extra expense. The teachers concerned acted wisely in not purchasing or renting such films. However, this should not deter mathematics teachers from attempting to keep abreast of developments in the field of mathematical films. More and more are being produced, although in comparison with films in other

fields, mathematics films are not far from the experimental stage. Teachers of mathematics should keep constantly in mind that motion pictures are of the greatest benefit, and make their greatest contribution to the educative process where ***motion*** is involved.

In another interesting comment we find expressed the belief that films have no great value except for advanced mathematics. The mathematics teacher interested in making or using motion pictures who is alert to such phrases as: "if point P approaches P′," "the area approaches a limit," "the number of divisions becomes infinite," "place AB on A′B′," "under pressure the circle becomes an ellipse," or "the angle increases," will have no scarcity of subjects. In short, by noting the thousand and one places where *change of position* (motion), *change of shape* (transformation), *correspondence*, or *limit* is implied, topics will be found. The secret is to use motion where it is implied in the mathematical argument, and where the expert and gifted mathematician supplies it with his intuition and imagination. This shows that mathematics films are not restricted to the field of advanced mathematics.

One teacher is inclined to feel that motion pictures "would be mere entertainment for high school teen-agers." Whether a film turns out to be mere entertainment or not depends to a large extent upon the teacher. Wise initial selection of a film, by the teacher, with a follow-up of discussion, testing, and reports by the pupils after the film has been shown will soon cause a class to look upon the films as instructional rather than entertaining.

Still another teacher voices the opinion that films and film strips are not constructively helpful, but merely review or entertainment. There could be little disagreement with the opinion expressed that films and film strips are excellent instruments for review of mathematical facts and concepts. However, it is not necessary to prove that a good review is constructively helpful, a statement which by many teachers might be considered as bordering on the axiomatic. Thus, while seemingly skeptical of the value of films and film strips, that teacher is actually voicing one of the strongest arguments for the use of these aids.

Most aids to learning "are interest arousers rather than truly educative aids." This opinion falls in the same category as the opinion expressed in the previous paragraph. A strong argument *for* the use of multi-sensory aids *is* the fact that the pupils' interest is aroused to a greater extent that could ever be accomplished by the traditional method of instruction. Is not an aid which arouses interest an aid to education? The positive answer to this question can be found in almost any text on educational theory and principles of learning.

Many comments come from teachers in favor of multi-sensory aids

who are prevented by circumstances from making much use of them. The factors which are obstacles to the use of multi-sensory aids may be outlined as follows:

1. Lack of time.
2. Lack of money.
3. Lack of information concerning aids to teaching.
4. Lack of facilities for use of some aids.

Of these four, the most common is lack of time. Mathematics teachers are kept so busy preparing students for College Entrance Exams that they have little or no time to investigate or use certain multi-sensory aids or "extras" as some would call them. Is this a valid excuse?

Let us look briefly into the matter of college entrance requirements in general and for mathematics in particular. Brammell discovered that comparatively few higher institutions of learning either recognize or require the examination of the College Entrance Examination Board.[1] Furthermore, the examination of the College Entrance Examination Board was discovered to be but one of twenty-one different avenues of college entrance.[2] Even in such college departments as science and engineering, which can reasonably be expected to require more mathematics than many others, the requirements ranged all the way from none to four and one-half Carnegie units.[3]

Lack of Money

Another prominent excuse is lack of money. This is obviously directed at the cost of projection equipment and materials. A Research Bulletin[4] of the National Education Association may help to throw some light on this subject.

The following table is adapted from this Research Bulletin: Per pupil expenditure on audio-visual education 1945–1946, in various groups of city school systems with audio-visual departments.

Population	Over 100,000	30,000 to 100,000	10,000 to 30,000	5,000 to 10,000	2,500 to 5,000	Average
Per pupil expenditure	$.32	$.57	$.83	$.89	$1.68	$.86

The above figures indicate that the cost of maintaining audio-visual departments is not prohibitive. However, in the last analysis, it is up

[1] P. Roy Brammel, "Articulation of High School and College," *Bulletin* 1932, No. 17, *National Survey of Secondary Education*, Monograph, No. 16 (Washington, D.C.) United States Office of Education, page 13.

[2] *Ibid.*, page 12.

[3] *Ibid.*, page 36.

[4] National Education Association, "Audio-Visual Education in City School Systems," *Research Bulletin*, 24: 165, December, 1946.

to the individual school systems to decide what can be set aside for the purchase and renting of multi-sensory aids. Much can be done if money is available. Paradoxical as it may seem, however, a great deal can be done with little or no money at all.

A wealth of pictorial material is obtainable literally for the taking in the countless popular magazines, pamphlets, advertisements, booklets so readily accessible to all. Magazines are particularly fertile sources of pictures which can be used in mathematics classrooms or laboratories; as pictures illustrating practical applications of mathematics in everyday life; geometry in architecture; higher mathematics in radio and electronic devices. The resourceful and imaginative teacher can guide the pupils in the collection, mounting, and preservation of pictures particularly pertinent to certain aspects or topics in mathematics.

Useful models can be made by pupils with an inclination toward this type of work at a very small cost. These models can be made from cardboard, wire, clay, balsa wood, celluloid, or any combination of these. The best models can be preserved along with the mounted pictures previously mentioned.

In every group, there are bound to be several individuals interested in photography. Under the teacher's direction, such individuals would doubtless delight in taking pictures to be converted into photographic lantern slides. Pupils interested in typing and drawing would need little coaxing to produce cellophane and etched glass slides as their contribution to the class stock of multi-sensory aids. If the work of making lantern slides is carefully planned, and the objects for each slide are carefully chosen to minimize waste, the cost per slide will average between ten and fifteen cents.

The attempt has been made to show that a considerable headway can be made in initiating and conducting a program of multi-sensory activities at a very small cost.

Lack of Information Concerning Aids to Teaching

Mathematics has been taught in the traditional way for so long that unusual or experimental work in this field is the exception rather than the rule. For this same reason, little use has been made of multi-sensory aids by mathematics teachers as a whole. However, while not as extensive as that in other fields, information on aids to the teaching of mathematics is available. Two periodicals in particular: *The Mathematics Teacher*[5] and School Science and Mathematics[6] make it a point to publicize experimental work on the improvement of instruction in mathematics. Many articles are to be found in these

[5] *The Mathematics Teacher*, 525 West 120th Street, New York 27, New York.
[6] School Science and Mathematics, 7633 Calumet Ave., Chicago 19, Ill.

periodicals on the use of aids to learning by resourceful and progressive teachers, and a monthly department "Aids To Teaching" now appears in the *Mathematics Teacher*.

Much information is to be obtained from companies which manufacture films, projectors, instruments, and other aids to learning, and from distributors of these aids.

Lack of Facilities for Use of Some Aids

A partial answer to those teachers complaining of lack of facilities for the use of certain aids, particularly films and other aids requiring projection equipment, has been given in the section dealing with cost. There are, however, certain implications, which cannot be answered so easily.

In the ideal situation, unlike the present situation in which a room may be used by a class in English one period then by a class in French, etc., a room is set aside for classes in mathematics only. This room will be equipped with opaque shades, a portable or permanent motion picture screen, and adequate electrical wiring facilities for the use of projection equipment.

In large high schools, even if not carefully planned at the time of their construction, the ideal situation as outlined in a previous paragraph can be approximated. This is harder in the small high school. The logical answer to this problem appears to be co-operation between small schools.

The duty of those concerned with the planning of new educational buildings is obvious. In weighing future needs and future practices, the best interests of pupils demand that adequate space provision and facilities be made available to teachers desirous of incorporating multi-sensory aids into their teaching procedure.

WORLD'S LARGEST HELICOPTER BOASTS DETACHABLE, BUS-SIZED CAPSULE

World's largest helicopter, the size of a DC-4 plane and equipped with a detachable capsule as large as a cross-country bus, is being developed experimentally for the United States Air Force.

Two prototypes are scheduled for delivery to the Air Force within the next two years by the Piasecki Helicopter Corporation, Morton, Pa., it was announced today.

Called the XH-16, the new twin-rotor plane will carry the heaviest load and have the longest range of any rotary wing aircraft yet developed. It is described as an enlarged, streamlined version of the XHJP-1, which has been successfully tested by the Navy.

The detachable capsule for speeding loading and unloading is estimated to nearly double the payload to be carried by the plane.

Uses proposed for the new, giant Air Force helicopter include transporting military supplies and personnel, evacuation of wounded or stranded personnel and rescue operations over land or water.

THE EFFECTIVE ADMINISTRATION OF HIGH SCHOOL BIOLOGY TEACHING UNDER STATE SUPERVISION

PART III. THE PUPIL GETS C

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(Concluded from January)

One who has had extensive experience as a quiz-marker for various institutions at differing educational levels is somewhat cognizant of the difficulties to be met. It is not at all uncommon in larger universities where classes in general biology, zoology, botany, hygiene, etc., run from a hundred to five hundred to have the staff meet in general session for paper correction. Questions are apportioned, answers standardized and agreed upon as to what to emphasize and expect, and results made as uniform as possible. Frequently when doubtful points arise the group can be called upon for collective opinion and the point at issue settled on the spot.

Enough oversight of such procedures has been had to establish the conviction that a given examination paper, particularly if it admits of subjectivity, may be graded by a group of persons, each properly qualified to pass judgment, with very unlike results. If you disbelieve and are a teacher, try yourself out. Correct a few papers then lay them aside and go over them later without reference to what your previous marking was. Find out how the same paper "strikes you" at that particular second moment. Essay questions are notoriously open to varied judgment and more than one trick has been played on teachers by students who have submitted almost identical themes with widely varying marks, etc.

When, however, a pupil states a fact which is called untrue by a supervising teacher the situation becomes a bit more easy to estimate. Pupil Y's paper illustrates the point. Here is the question as it appeared on the official state test paper:

"a. Your body has many defenses against invasion by bacteria. How does *each* of the following aid in protecting you against disease: . . . cilia . . . ?"

Y answered, "The cilia in the nose filter out the germs that come in by breathing."

The local school administrator who criticized this paper with Y's parent told her flatly that "There are no cilia in the nose." His authority for the statement was "a high school biology teacher of fifteen years' experience." He did not go to the university biology department headquarters where he could have found out from a dozen textbooks, of various kinds, an authoritative statement to the con-

trary such as that in Maximow and Bloom's (3) excellent and widely used medical treatise on normal histology. Neither did the biology teacher of long experience know his or her sources too well for it should have been known that Moon and Mann (4), typical of its kind, says, concerning cilia, "These are in constant waving motion, and carry up toward the mouth any dust or dirt taken in with the air. The *nasal passages* (italics are the author's) are also lined with cilia for the same purpose."

What did the assistant state examiner do with this answer when he corrected it? We can but wonder. What was S's answer to the same question? Here it is exactly as written:

"b. Cilia—there is cilia in the nose that filters the air as it comes in taking out foreign bodies. There is also cilia in the opening to the lungs where the germs are also filtered out."

Both answers could have been more adequately and exactly expressed though some college students and even some scientists would do little better. It has to be assumed, for we do not know, that S was considered wrong and credit denied. Some decrease in points might have been justified if grammar and spelling were made the basis for correction. S was not without fault there in a number of cases. As a short answer, valued one point, "peralsstyalsis" appeared on the scratch paper. Of course *peristalsis* was intended. What would half a dozen different markers do with this? Would not some claim it to be entirely correct, others incorrect, a few partly correct? "Celulose" and "sedamentary" were additional misspellings. Rated as right or wrong? How many letters in a word does one have to have misplaced or changed to be considered of no credit?

When we begin to criticize in this fashion some of us ask what is the design behind a test anyway? What is really vital? Do mere word answers reveal understanding and the ability to express ideas? If "peristalsis" is recognizable as the name of a process of a given kind is it fair or isn't it to allow credit to the user? On the other hand if the word is so warped that it would not be known for what it really is when encountered in the proper spelling, then could credit be justifiably withdrawn? Only by trying the person out with the reading of the word could one surely tell. Therefore a judgment has to be made. In this case possibly the parent knows quite as much about the ability of the pupil to measure up to the trial as his teacher.

With regard to the discussion of cilia both pupils were essentially correct, at least two biology teachers and one administrative officer were wrong. Who, then, judging from this point alone to say nothing of many others mentioned hereafter, would be better qualified to score these two papers, a college teacher of histology who would very

likely know that the nasal cavity contains certain patches of ciliated epithelium to prevent the entrance of germs in dust, or a secondary school teacher who had never investigated, probably, the detailed side of tissue structure in the human body?

A second question read:

"Give an example of a plant or an animal that has been improved by breeding. Describe *one* method that has been used to bring about this improvement."

Y wrote:

"Wheat has been improved by breeding," continuing as to "method," "By crossing types with good characteristics and bad ones with other types with good and bad and selecting the types with only good characteristics improvements have been made. The good types are inbred to keep them pure."

Credit for both performances was denied because a *particular species* of plant or animal was not specified! What, in the mind of the asker or corrector constituted "an example of a plant or an animal?" Would you have accepted the answer from a fifteen-year-old high school sophomore who, along with his classmates, had to learn largely by himself the facts the text presented? An interested parent who visited the class, herself a successful educator, regretfully remarked that little direction was being given to instructional matters. By interesting coincidence the author read Y's words almost verbatim in an article of genetical import recently in "Science." Would they have been a satisfactory "example" for the examination readers?

A third question says:

"The following statements are true. Choose *five* and in each case give a reason why the statement is correct." "h. Conjugation is a form of sexual reproduction." Is this the same as asking why a true statement is true and isn't it awkwardly put? Would it have been better to say "Explain the statements of fact," if it was desired that a biology class dealing with those facts should need to be informed of their correctness?

Y wrote, not too grammatically,

"Conjugation is the instance when two simple plants or animals exchange parts of their nuclei." In spite of its taking a learned dissertation to present fully why protozoan or algal conjugation are similar to a typical sexual act as defined in biology it is clear that the pupil caught the significance of the comparison through his bringing out the idea of the exchange of nuclear parts. Ciliate protozoa are not cited, nor that one micronucleus migrates while the other remains stationary, nor that the macronucleus dissolves and disappears; nor that whole nuclei travel from one cell to another, in the conjugate

algae. Y did show that conjugation has more than one meaning, is found in widely different organisms. Were those who formed the test aware of this? Part b of the same section read:

"In mammals the two sexes are generally produced in about the same numbers." Y's answer as to why this "true" statement is "correct": "The XX chromosome is the female and the XY is the male. When they are crossed half the offspring will be male and half female."

Credit was not given for either "h" or "b." It was explained that the conventional monohybrid line-symbol diagram was not included as illustration. Such is not called for. "Give a reason" is the direction, not a figure. Y presented the sex-chromosome constitution, the cross possible, showed beyond doubt that he knew what was being considered. Did the assistant examiner have a stereotyped list or printed form to follow which had been issued to local markers for reference? If so, it would be an intriguing document for inspection.

Especially, because one statement, called "true," namely that "The sperm nucleus of a higher plant is only one of the two nuclei of a pollen grain," happens to misrepresent the truth! Instead it is a *generative* nucleus from which by division *two* sperm (male) nuclei form (5). What reason could a properly informed biologist give for the correctness of an untruth? But suppose that it were right what *reason* could be given for a certain cell body being only one of two? "Why is one of the two pollen grain nuclei called generative?" makes a meaningful query. But it wasn't asked that way.

Awkward phraseology occurs frequently throughout the examination. This confuses and leads to error, a point completely overlooked in the grading process it was discovered. S wrote, for example, "protoplasm" in the completion blank for "The living substance that surrounds the nucleus of plant and animal cells is. . . ." She was well within reason in doing so. All living matter is protoplasm. The fault lies in the wording.

Y wrote "goiter" in finishing "A disease characterized by an abnormal growth of cells is called. . . ." and is certainly correct. The expected word, it was discovered, was predetermined to be "cancer." Numerous bodily ailments exhibit "abnormal cell growth." *Rate* of multiplication is not suggested. Therefore the pupil is penalized for original application and thinking of a condition which fits perfectly. It so happened that the parents of a third pupil confirmed the conclusion, for their son replied exactly the same way.

Unfortunately for discipline and morale a number of disputatious individuals had been noting instructional mistakes. Y was not among them. When his rating dropped for a quarter from A to C concern was felt and parental enquiry instituted. Y had kept all his written

work. None had received less than A. No explanation for the lowered marking could be offered. A current issue of the *Saturday Evening Post* shows a cartoon in which a young hopeful with a sweetly pacifying expression looks up at her glum father who is scanning her report card, saying in docile explanation or apology, "I don't raise my hand enough." There is a little acid in that, reminiscent of former classroom experience. Haven't you had more than a few whose hands were always waving wildly in the air but whose performance was pitifully inadequate as compared with some of the more shy, quiet kind who listened, thought a lot, and said little but made each word count?

In order to demonstrate that analysis of the two papers now discussed was measurably judicial and unbiased there were points that the author would criticize which the official graders overlooked. S, in a completion sentence, gave as often happens, two answers (for good measure?) to "An organism that commonly reproduces by budding is. . . . " They were "yeast" and "Spirogyra." If water silk buds the records of it are very obscure. What to do then with an answer half right, half wrong? Was it understood as to what budding really is, its purpose and meaning in the living world? The example merely indicates a possible memorized case. Is that important or is it more worthwhile to know the significance of asexual reproduction? Had your pupil performed thus would you feel you had failed in your presentation of the topic?

In question 9-a-1 three different ways in which insects are harmful to man are required *with examples*. Both S and Y omitted the examples (illustrations). Full credit was given! When no instance had been called for in another place, with none cited, Y was graded downward. Here, with such specified, no points were deducted. However, the author scored both performances as rigidly as he had ever done so for any of the numerous general biology and general science youth he had formerly taught in secondary school and still got figures ranging from four to ten degrees higher than the formal tabulations!

Next is an example of the way difference in opinion might arise concerning values. Y was writing a "discussion" in which "specific facts" were desired on two of three topics. He chose "the reason for rotation of crops" and "a method of erosion control." This section had already had two parts, answered with full credit. Four points, two per subject, were allotted. Y's treatment was brief but entirely factual. His reason for rotating crops, (only one was specified) stated that "The rotation of crops will prevent the soil from losing its richness and will re-enrich some soils." No credit was received.

As a method of erosion control he was likewise very brief in writing "By building check dams to control streams soil will not be lost." One point was assigned. The particular text used has no lengthy de-

scription. To what extent conservation ideas were developed is unknown. Judgment here seems too strict.

If the ordeal of these appraisals is hard for the takers it is no less so for those teachers who take their job seriously and few do not. Couldn't their burdens, often very heavy, be eased somewhat by superiors who should be aware of details involved and all requirements? What must be the feeling of a careful, conscientious person who has prepared a class faithfully in fundamentals, who has emphasized logical choice and discrimination, and has cultivated an attitude of critical ability, the keystone of the scientific approach, to see ambiguities and mistaken notions appear where all should be transparent and exact? There would be no cause for complaint if an occasional error crept in through the years. Why all the fuss and bother unless the prime aim of accuracy is not reached?

What excuse justifies a multiple choice statement such as the following?

"The part of the flower that forms the seed is the (1) ovary (2) ovule (4) receptacle (4) stigma."

Morphological and developmental botany reveal the discrepancy. This is not a matter of obscure information nor lack of sources for reference. The knowledge is easily accessible, within reach of any who wishes to take a few minutes for careful perusal and consistent relationship of ideas. Six college botanies and two modern general biologies in recent editions, plus two up-to-date general biologies for high school, are all before me, (6–15) with a dozen others as readily at hand. In each can be found everything that anyone needs to know to see the confusion existent in such a declaration.

First, merely the word "flower" is used, not *typical* flower. "Everyday Biology" (16), the adopted text, defines in its glossary, page 661, a "flower" as "the part of a seed-bearing plant that contains the reproductive organs," a technical definition, scientifically and botanically correct. Early in the book, page 55, there is a clearly drawn, excellent, life-like diagram of a "typical flower." Even this adjective, newly used, is explained in a footnote for the sake of complete clarity. The figure appears in connection with an exercise (experiment) for the purpose of teaching an important biological principle, that of division of labor. Incidentally it shows the structure of a distinctive plant organ, the blossom.

The drawing is carefully labeled, accurately and adequately. Since many botanists do not include the receptacle among the major flower parts its omission here is pardonable. Six common flowers (apple, tulip, lily, petunia, violet, buttercup, morning glory) are mentioned, any one of which might serve for the study, although each departs in

distinctive ways from the illustration. By means of appropriate comment the anatomy is brought out.

The pistil, composed of stigma, style, and ovary (called "ovulary" by some botanists), is plainly indicated with each part named. Within the ovary is a single ovule. In describing the latter the text says that the ovules "may develop into seeds." These flower portions show that work in the organism is distributive and co-operative, an example of "division of labor."

Thus far all would seem perfectly clear. But evergreen trees like the conifers are seed producers also. Do such have flowers? Technically and botanically, yes. The pine cone and its tassel constitute the State of Maine official emblem in that respect. Pages 142–3 of the text bring the anatomical fact to light, with proper scientific discussion. Two large groups of seedbearers, then, are distinguished, gymnosperms and angiosperms. The latter are described as ". . . the true flowering plants, in the sense in which the word flower is commonly used." Note the importance of that key word "commonly." A technical test for statewide distribution makes no notice of the distinction between "flower" in a scientific sense and its meaning popularly, but *assumes* that the latter will be that adopted by the reader. We presume that the difference was realized but overlooked. We also must believe that the discrepancy which occurs to throw off an informed person, causing him to wonder as to what choice to make that "best" covers the case in the rest of the statement, was also undiscovered by any of the critics who inspected the examination before its approval.

Note now the wording of the sentence, the part of the flower (assumed to be typical) that *forms* the seed is first, ovary, second, ovule, third, receptacle, fourth, stigma. Plainly, unless he were wildly guessing, it cannot be the last that produces the seed for it is the receptive surface on which the pollen falls. Third term is unlikely since it is a direct or indirect location point for sepals, petals, etc.

Since the ovules in the course of development are transformed, made over as they mature, into seeds, this could be a logical selection. But equally correct is it that the ovules are produced from the inner walls of the ovary. The ovule, originating in the ovary, is an incipient seed, a preliminary stage in its formation, with embryo, some enclosed food, and protecting integuments. Each has its particular embryonic derivation, all from the ovary. Perhaps the teacher has traced very painstakingly the long sequence of events and developmental relations involved. Seeds are thus integral parts of plant ovaries and the dilemma is unwarranted. By using "develops or matures into" there could be no chance for doubt.

The apparent purpose of the question list is to reveal the pupil's knowledge and understanding of the biological realm. Typical companions to the one just examined are those which immediately precede and succeed it. One asks that a choice be made between Amoeba, Euglena, Hydra, and Paramecium as examples of animals that move by "means of pseudopodia." Another is a selection of a bacterium, a virus, eyestrain and vitamin deficiency as the cause of night blindness.

In the first it is necessary to know that Amoeba moves by pseudopodial action, the characteristic method of locomotion for the protozoan class of Sarcodina. If the pupil knows the regular form and behavior of the other three, by elimination he knows that Amoeba must have the pseudopodial method. He is confused by nothing that needs interpretation because of a double meaning.

In the latter case he must know the nature of the disease night blindness else his answer will be a mere guess with strong chances against its being the right one. He could be deceived into listing eye strain as a possible cause through the connection between weak eyes and poor vision. It is difficult to see how by any stretch of the imagination he could associate either bacteria or viruses with inability to see in the dark. If he has had any contact at all with vitamins and their role in nutrition he should readily make the association between the lack of one or more of them and a disturbance in vision. Here there is a possible demand for sound thinking plus recall of factual matter, but scarcely any hidden trickiness to make the choosing of a "best" answer particularly troublesome.

Both S and Y produced commendable results with the objective portions of the examination in spite of its errors. Both chose "ovule" as the "best" answer for the question we have criticised and seem to have been given credit for the same. The story is a little different with number 39, also multiple choice. It reads: "The part of the neuron that is covered with a fatty sheath is the (1) axon, (2) cyton, (3) dendrites, (4) end branches." S selected the axon, confirmed as correct when Y's paper was inspected. Y, however, did not answer this at all. In correcting his paper the legitimate query immediately arises as to whether to consider the item or ignore it completely. The reason for doubt is that there are two kinds of major neurons to which such a description could apply, motor and sensory, both equally important and common in the nervous system. For an excellent representation and discussion of these, understandable by anyone, consult Millard and King (17), page 383. In the motor neuron of the interior of the spinal cord the dendrites and end processes are short and without the fatty (myelin or medullated) sheath which the long axon process, traveling out and away from the cord, possesses. But in the sensory

neuron of the dorsal ganglion, found outside the cord, the reverse is true to this extent, *both* axon and dendrite have the fatty sheath! The cyton (cell body) in each instance lacks this coating.

Thus in question 39 the pupil is confronted with making a choice between two answers, axon and dendrite, both of which would be correct for one type of neuron, only one of which is correct for the other. There is no mention made as to which type of neuron is intended. Is this because the devisers of the test did not know that both existed, or maybe, knowing that there were several types, they did not realize in what respects they were cytologically different?

One might well ask here can it be that those who control the making, and perhaps the correcting, of these tests are getting beyond their depth? What would be the importance, and the purpose, of such a question anyway? It goes into histological detail of interest only to the specialist in the medical field or research biology. How long will high school sophomores retain a bit of information which relates to a layer of fatty material surrounding a nerve fiber? Would it not be much more to the point to stress the general composition of a typical neuron or those divergences in form and function which would add to understanding and appreciation of the tissue make-up of nervous matter?

At present no biologist can state with certainty the use of this myelin sheath nor explain why, broadly speaking, the autonomic nerve fibers lack lipoid whereas the central nervous system division fibers possess it. Pupil, teacher, and parent are thus presented with ultimatums that serve merely to irritate and detract from true learning and its ends.

No biologist can carry the sum total of his facts and figures at his finger tips for instant reproduction *so all-inclusive is the field.* But everyone pursuing the subject can recheck his background of information, is able constantly to read and study, thus keeping somewhat abreast of the unceasing, onward march of progress. He can familiarize himself with the reliable source books for knowledge and learn to discriminate between what is authoritatively current and what is grossly behind the times.

Parents who con budgets for family needs, straining them to the extent of sacrifice that children may be better educated, as this particular advantage becomes more and more a prize for the favored few if the recent report on higher learning is reliable testimony, see the unfairness involved, register protest quite properly and receive disturbing assurance that a report is confirmed and there is no recourse.

If the parent knows the facts fairly well himself he cannot be but aroused over the outcome. A daily record, faithfully and conscientiously earned, is finally marred because of ignorance not the pupil's

own. The good teacher, and there are scores of them, is caught in a system's log-jam with attendant circumstances he is largely powerless to prevent. The poor instructor, blunderingly unaware of his incapacity, is dull to the consequences. Keeping his job may be his main concern. When he is removed from it he has the comforting consolation that the exigencies of the times will very likely provide him with another.

Somewhere along the line a shake-up and revaluation are needed. The core is sound but the surface is spotted. Introspection and forthright action might effect a cure before it is too late and the fruit is entirely spoiled. No new theories of educational procedure need be invoked. The real task is to make more effective what we already have that is potentially admirable and at our disposal.

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Peepholes for apartment house doors are made with a recently developed "one-way" glass through which the person on the inside can see out, but which is a mirror to the visitor on the outside. The device is a door fixture, with a polished brass frame, that can easily be installed in any type door.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2103. *Gerald Sabin, Tampa, Fla.*

2104, 5. *B. F. Plylon, Huntington, W. Va.*

2101, 2, 4, 5, 6. *C. W. Trigg, Los Angeles City College.*

2107. *Proposed by Laura J. Amer, Pontiac, Mich.*

Without actually expanding solve:

$$(12x-1)(6x-1)(4x-1)(3x-1)=5.$$

Solution by Felix John, Ammendale, Md.

Write the given equation thus:

$$(12x-1)(12x-2)(12x-3)(12x-4)=120.$$

Substitute $y=12x$:

$$(y-1)(y-2)(y-3)(y-4)=120.$$

Combine the first and fourth factors and the second and third:

$$(y^2-5y+4)(y^2-5y+6)=120.$$

Substitute $z=y^2-5y$:

$$(z+4)(z+6)=120 \quad \text{or} \quad z^2+10z-96=0.$$

Solving: $z=6,\ -16.$

Replace z by y^2-5y:

$$y^2-5y-6=0 \quad \text{and} \quad y^2-5y+16=0.$$

Solving:

$$y=6,\ -1,\ \frac{5\pm i\sqrt{39}}{2}.$$

Replace y by $12x$ and solve:

$$x=\frac{1}{2} \quad -\frac{1}{12} \quad \frac{5\pm i\sqrt{39}}{24}.$$

Other solutions were offered by C. W. Trigg, Los Angeles City College; D. McLeod, Winnipeg, Canada; Mary Leona, Detroit, Mich.; Max Beberman, Shanks Village, N. Y.; Hugo Brandt, College Park, Md.; Mary E. Richards, Northbrook, Ill.

2108. *Proposed by Felix John, Ammendale, Md.*

A 30-60-90-triangle has the same perimeter as an isosceles triangle whose vertex angle is 120°. Find the ratio of their areas.

Solution by Aaron Buchman, Buffalo, N. Y.

Let x be the side opposite the 30° angle of the 30-60-90 triangle. Then the perimeter of the 30-60-90 triangle is $p_1=x(3+\sqrt{3})$, and the area of this triangle is $K_1=\frac{1}{2}x^2\sqrt{3}$

Let y be the altitude drawn from the 120° angle of the isosceles triangle. Then the perimeter of the isosceles triangle is $p_2=2y(2+\sqrt{3})$, and the area of this triangle is $K_2=y^2\sqrt{3}$

Since it is given that $p_1=p_2$ then,

$$x(3+\sqrt{3})=2y(2+\sqrt{3})$$

and

$$\frac{x}{y}=\frac{2(2+\sqrt{3})}{3+\sqrt{3}}$$

so that

$$\frac{x^2}{y^2}=\frac{2(2+\sqrt{3})}{3}.$$

But

$$\frac{K_1}{K_2}=\frac{\frac{1}{2}x^2\sqrt{3}}{y^2\sqrt{3}}=\frac{x^2}{2y^2}.$$

Therefore,

$$\frac{K_1}{K_2}=\frac{2+\sqrt{3}}{3}.$$

Solutions were also offered by Irwin L. Baily, Detroit; P. S. Marthakis, Salt Lake City; C. W. Trigg, Los Angeles; Dativus Gabriel, Philadelphia; Felix John, Ammendale, Md.; Norma Sleight, Winnetka, Ill.; Mary Leona, Detroit; Hazel S. Wilson, Annapolis, Md.; Max Beberman, Shanks Village, N. Y.; R. O. Reiner, Martinez, Calif.; Hugo Brandt, University of Maryland; Aleyone Lawson, Chicago; Mary E. Richards, Northbrook, Ill.

2109. *Proposed by V. C. Bailey, Evansville College, Evansville, Ind.*

Evaluate the expression:

$$\lim_{x\to 0} (\sin x)^{1/x}.$$

Solution by the proposer.

(1) Let $y=(\sin x)^{1/x}$.

(2) Then $\ln y=\dfrac{\ln \sin x}{x}$

(3) $\lim\limits_{x\to 0} \ln y=\lim\limits_{x\to 0} \dfrac{\ln \sin x}{x}$

(4) $\lim\limits_{x\to 0} \ln y=\dfrac{-\infty}{0}=-\infty$

(5) $\lim\limits_{x\to 0} y=e^{-\infty}=0.$

(6) Therefore, the $\lim\limits_{x\to 0} (\sin x)^{1/x}=0.$

Hugo Brandt, University of Maryland also offered a solution.

2110 and **2111.** Solutions have not yet been offered.

2112. *Proposed by A. R. Jones, Marion, Ohio*

Find a simple value for

$$[(\csc x-\sin x)(\sec x-\cos x)]^{2/3}[(\csc x-\sin x)^{2/3}+(\sec x-\cos x)^{2/3}].$$

Solution by Max Beberman, Shanks Village, N. Y.

$$\left[\left(\frac{1}{\sin x}-\sin x\right)\left(\frac{1}{\cos x}-\cos x\right)\right]^{2/3}\left[\left(\frac{1}{\sin x}-\sin x\right)^{2/3}+\left(\frac{1}{\cos x}-\cos x\right)^{2/3}\right]$$

$$=\left[\left(\frac{\cos^2 x}{\sin x}\right)\left(\frac{\sin^2 x}{\cos x}\right)\right]^{2/3}\left[\left(\frac{\cos^2 x}{\sin x}\right)^{2/3}+\left(\frac{\sin^2 x}{\cos x}\right)^{2/3}\right]$$

$$=[\cos x \sin x]^{2/3}\left[\frac{\cos^{4/3}x\cos^{2/3}x+\sin^{4/3}x\sin^{2/3}x}{\sin^{2/3}x\cos^{2/3}x}\right]$$

$$=\cos^2 x+\sin^2 x$$

$$=1.$$

Solutions were also offered by Margaret Joseph, Milwaukee; Felix John, Ammendale, Md.; C. W. Trigg, Los Angeles; Norma Sleight, Winnetka, Ill.; P. S. Marthakis, Salt Lake City; Irwin L. Baily, Tiffin, Ohio; Mary Leona, Detroit; Hazel S. Wilson, Annapolis, Md.; R. O. Reiner, Martinez, Calif.; Hugo Brandt, University of Maryland; Mary E. Richards, Northbrook, Ill.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

2112. *Albert Ottavian, Winnetka, Ill.; Donald Post, Donald Heinmer and Richard Baldwin, Butler, N. J.; Arnel Potter, Monterey, Calif.*

2104. *Robert P. Schaefer, Tiffin, Ohio; Richard R. Cooper, Fairbanks, Alaska.*

2108. *Janet Hanssen, Kenilworth, Ill.*

2112. *Oscar Hillig, John Beardsley, Phil Swett, Richard Newman, Robert Kessie, James Lingeman, Dick Twinlan, Hugh Beath and Joe Jenisto—all of Lyons Twp. H. S., La Grange, Ill.*

PROBLEMS FOR SOLUTION

2125. *Proposed by Felix John, Ammendale, Md.*

Through the excenters of triangle ABC lines are drawn parallel to the three sides, thus forming another triangle $A'B'C'$. Prove that the perimeter of triangle $A'B'C'$ is $4r \cot \frac{1}{2}A \cot \frac{1}{2}B \cot \frac{1}{2}C$, where r is the radius of the circumcircle.

2126. *Proposed by Hugo Brandt, College Park, Md.*

Prove the identity: $\sec x + \tan x = \cot(\pi/4 - x/2)$.

2127. *Proposed by Norman Anning, University of Michigan.*

Given the curves: $y = x^3 - 3x$ and $x = y^3 - 3y$. Show that the positions of all nine of their intersections are by straight edge and compasses constructible.

2128. *Proposed by V. C. Bailey, Evansville, Indiana*

If the squares of the sides of a triangle are in A. P., show that the tangents of its angles are in H. P.

2129. *Proposed by Aaron Buchman, Buffalo, N. Y.*

Derive the relation which can be used to write the set of integers, such that the square of each of these integers is equal to the sum of the squares of two consecutive integers.

2130. *Proposed by Howard Grossman, New York*

Each side of a triangle is divided into n equal parts and lines are drawn parallel to the sides of the triangle and joining these points of division. Show that if n is even the total number of triangles is $n(n+2)(2n+1)/8$. What is the number if n is odd?

ATOMIC DETECTIVES

"Atomic detectives" are being used by scientists at the University of Wisconsin to study surface layers less than a millionth of an inch thick. Surfaces of silicones, compounds with characteristics of both glass and oil, are being used in the studies.

This basic research is veing carried out at the University under the direction of Prof. John E. Willard and may lead to the development of surfaces of value in research or industry. The work is supported by the Wisconsin Alumni Research foundation.

An "atomic detective" or tracer is a radioactive atom that "radios" its position by sending out a high speed electron. These electrons can be counted by a simple electrical device called a Geiger Counter.

The "detectives" are radioactive twins of ordinary atoms and are produced by a chain-reacting atomic pile at Oak Ridge, Tenn. Since they behave as normal atoms in every other way and go along with the crowd, the scientist can learn where the crowd has gone by spotting the "detectives."

A mixture of radioactive and ordinary bromine is made to react with a surface A roll call of radioactive atoms after the reaction tells the scientist just what has taken place.

Early experiments indicate that the bromine not only combines with surface molecules but with molecules in as deep as 30 molecular layers (about three tenmillionths of an inch).

By replacing bromine with other chemical groups, the scientists hope to change the characteristics of the surface without changing the properties of the bulk of the substance. Here the detectives will play an important role by indicating the completeness of the replacement reaction.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS REPORT OF THE INDIANAPOLIS MEETING

President John E. Potzger called the meeting to order at 7:45 P.M., November 25, 1948, in Parlor E of the Claypool Hotel. The following officers and Board members were present:

Miss Mary E. Potter	Mr. F. Olin Capps	Mr. Ralph W. Lefler
Mr. Ray C. Soliday	Dr. Charlotte Grant	Mr. Donald W. Lentz
Mr. Fred W. Moore	Mr. Walter N. Smith	Mr. Lorne M. McKenzie
Mr. Bjarne R. Ullsvik	Mr. Paul L. Trump	Mr. H. Vernon Price

Others in attendance were:

Mr. George Hawkins	Mr. Fred Leonhard	Mrs. Geraldine Johnson
Mr. Arthur Baker	Dr. Glen W. Warner	Mr. Walter Gingery
	Mrs. Marie Wilcox	

President Potzger expressed his appreciation for the kindness, cooperation, and good will which had been extended to him by the members of the Central Association of Science and Mathematics Teachers. Dr. Potzger stated that the duties and activities in which he had engaged while serving as President of CASMT had made this one of the happiest years of his life. He expressed the opinion that the year's success was as much the result of the splendid cooperation which he had received from the Board of Directors, officers, and the committees which had worked with him as it was the effort he expended. The work of all these people was genuinely appreciated. President Potzger said that it was a distinct pleasure to work with this organization.

The feeling of the Board was expressed by Dr. Potzger when he stated that all were deeply grieved at the passing of Mr. Emil L. Massey, a former president of CASMT and one of the strong supporters and diligent workers in our organization. The Board stood in silence as a tribute to the memory of Mr. Emil L. Massey.

President Potzger gave a written report on general facts of interest to the organization. He stressed the need for more planned publicity especially in the journals of other organizations. The need for a general publicity chairman to stimulate interest in our Convention was discussed.

Mrs. Marie Wilcox, general chairman of local arrangements committees, gave a report of her committees' work. She expressed gratitude for the magnificent cooperation she had received from the President, the Board of Directors, and her committees. The local membership committee, under Mr. Carl Hanske, had secured new members. The publicity committee, under the chairmanship of Miss Mona Wilson, had advertised this Convention far and wide. The newspaper publicity which CASMT received was the best in the history of the association. Mr. Virgil Heniser, chairman of facilities for meetings and his committee had secured the desired equipment which had been requested by the various Sections and Groups. Mr. Enoch Burton would make his report on the statistics at the Saturday Board meeting. A noon luncheon was omitted, but movies would be shown in the Chateau Room from 11:30 A.M. to 2:30 P.M. for any members or guests who cared to attend. Tickets to a radio program had been secured for members and guests who cared to attend. A reception in the Chateau Room was to be held before the banquet. After the banquet a social hour was planned. This also would be held in the Chateau Room.

Mrs. Wilcox reported that a sufficient number of reservations had been made for the banquet so that it would be possible to reduce the price of the banquet ticket from four dollars to three dollars and fifty cents.

Mr. Ullsvik moved, Mr. Moore seconded the motion, and it was passed that if the local committee finds it desirable, the Board would favor a reduction in the price of the banquet ticket from four dollars to three dollars and fifty cents. The final decision is to rest with the local committee.

A discussion concerning ways of securing banquet reservations early rather than so late, was discussed. The suggestion that a double post card be used seemed to receive favorable comment.

The Board expressed its appreciation and thanks to Mrs. Wilcox and her committees for their splendid work in making this Convention possible.

Mr. Leonhard, chairman of the Membership Committee, reported that this year had witnessed one of the heaviest registrations on Thanksgiving evening for a long time. He stated that before the Convention began we had 1040 members as compared to 1044 of last year. Of these 1040 members, 168 were from Indiana. The Board complimented Mr. Leonhard on his work and expressed its thanks for a job well done.

Mrs. Geraldine Johnson, editor of the Yearbook, gave her report. As is generally true when the Convention is held outside of Chicago, the number of exhibitors decreased. There are thirty-two this year as compared with forty-three last year. Mrs. Johnson expressed the opinion that the Yearbook would pay for itself, but no profit was expected. The Board thanked Mrs. Johnson for her report and complimented her for her good work.

Mr. Walter Gingery gave the report of the Journal Committee. Circulation of the Journal was down a little, but the cash balance was a little more than it was a year ago. The cost of printing has gone up. It is important to make magazine advertising pay so as to interest advertisers. The question of Emeritus memberships needs to be discussed. Mr. Gingery's report was accepted with thanks.

Dr. Glen Warner, editor of SCHOOL SCIENCE AND MATHEMATICS, gave his report. Next year's cover for the Journal was discussed. Mr. Warner submitted colors from which a selection could be made. Mr. Warner said he would appreciate having suggestions and comments. He also stated that money is needed to send the Business Manager on trips to contact the companies in order to sell advertising in the Journal. Mr. Warner felt that the companies should be made aware of the benefits they receive from the book reviews which appear in the Journal.

Mr. Ray Soliday, treasurer and business manager, gave his report. He submitted a written statement of the financial status of the organization. He called attention to the fact that the association had a balance of nine hundred dollars on last year's business. We took in more, but we also spent more. Printing costs are severe. Sixteen hundred dollars was made from the sale of back issues. Mr. Soliday does not expect that to happen again. Volume One of the Journal is now complete, but other volumes still remain incomplete. Circulation is almost exactly what it was two years ago; it is about as good as it has been since 1938. The increase in the rate has not effected the circulation, however, Mr. Soliday would like to see an increase in the circulation. He thinks that the question of selling advertising in the Journal should receive some consideration.

Dr. Grant moved and Mr. Hawkins seconded the motion that the Journal Committee make a special study of the advertising problem to see if some means can be worked out whereby more advertising in the Journal can be sold. The motion carried.

Mr. Soliday called attention to the study of Emeritus memberships which had been started and suggested the value of continuing such a practice.

Mr. Lefler moved, Mr. Hawkins seconded, and it was passed that Mr. Soliday and the members of the Journal Committee who are present at the Convention take the information which is available and, using this information and any other material available, present at the General Meeting Saturday morning the names of the individuals who are to receive Emeritus memberships.

The Report of the Resolutions and Policy Committee was made by Mr. Fred Moore. The report follows: The Resolutions and Policy Committee

1. Recommends that all research committees now organized be continued.
2. Hopes it will be possible to organize several more of these small groups in areas relatively close together.
3. Recommends that the report of the research committees be made a part of

the annual program of the Association either at the general meetings or in the sectional meetings.

4. Recommends that if these committees produce worthwhile research reports, publicity should be given through publication in SCHOOL SCIENCE AND MATHEMATICS.
5. Hopes the Board of Directors will do everything possible to secure the cooperation of large groups of teachers to make contributions through research, reports, and writing articles which will help improve classroom teaching.
6. Hopes the Association will appoint a committee or committees to help plan and develop a continuous program in science and mathematics from the kindergarten through the junior college. This program should be planned so that boys and girls with unusual ability will be given the opportunity to take courses which are a real challenge to their abilities.

Mr. Hawkins moved, Miss Potter seconded, and it was passed that the supervision of these special research committee groups remain under the Resolutions and Policy Committee.

Mr. Trump moved, Mr. Soliday seconded, and it was passed that requests for budget and financial matters needed by the research committees be presented to the Board of Directors by the chairman of the Resolutions and Policy Committee.

The Board seemed to be in agreement that a request for postage from the Resolutions and Policy Committee could be paid out of the Miscellaneous fund. Mr. Soliday, the treasurer, was to use his judgment as to the amount available for such purposes pending a request from the chairman of the Resolutions and Policy Committee to the Board of Directors.

The Board expressed its appreciation of the splendid work which had been accomplished by the Resolutions and Policy Committee and its sub-committees. The report was received with thanks.

A written report of the Committee on the Anniversary Publication was presented by Mr. Carnahan, editor of the Gold Book. The report showed that the work of the committee was well in hand and that all indications pointed to the completion of a splendid book in time for the celebration of the fiftieth anniversary of the CASMT.

Mr. Trump moved, Mr. Capps seconded, and it was passed that a committee of three be appointed to work with Mr. Soliday in handling the business with Mr. Carnahan, the editor, in the publication of the Gold Book.

Mr. Trump suggested that there were two possibilities which might be considered in publishing the Gold Book:

1. Have some publisher take over the publication of the Gold Book.
2. The Association might take over the publication of the Gold Book and thereby receive the profits or take the loss which might accrue.

The Board discussed the advantages and disadvantages of cooperating with affiliated teaching organizations and groups in the AAAS meeting. Mr. Lefler moved, Mr. Ullsvik seconded and it was passed that the discussion be tabled until the May meeting of the Board of Directors when more specific information concerning the AAAS meeting could be obtained. Mr. Lefler stated that he would be able to give more detailed information at the May meeting.

Mr. Trump moved, Mr. Hawkins seconded and it was passed that the President appoint a chairman to meet with the chairmen of the Sections of CASMT on Saturday after the close of the Convention to help them make plans for the following Convention programs.

Mr. Arthur O. Baker, representative of CASMT to the AAAS Cooperative Committee, presented a printed report on the recent work of the Cooperative Committee on the Teaching of Science and Mathematics.

Mr. Baker, chairman of the By-Laws Revision Committee, submitted a written report of the changes which the committee recommended. Mr. Baker said that his committee had incorporated the changes which had been suggested by

the Board at its May meeting and had also included other suggested revisions. Mr. Potzger pointed out that according to our by-laws no official action could be taken until proposed revisions are published in two successive issues of the Journal and for that reason no action can be taken at this Convention.

Mr. Ullsvik moved, Miss Potter seconded the motion that each member of the Board study the by-laws and the revisions suggested by the Committee. If the Board had any further suggestions to make, send these suggestions in written form to Mr. Baker so that he and his committee could incorporate these suggestions if they saw fit and ask Mr. Baker to make a report on the revisions of the by-laws at the May meeting of the Board. The motion carried.

Mr. Baker signified that his committee would take these suggestions and a report would be made by the committee at the May meeting of the Board.

Mr. Lefler moved, Mr. Trump seconded, and it was passed that the question of awarding honorary memberships to past presidents of CASMT be studied by the Journal Committee.

Mr. Hawkins moved, Mr. Lefler seconded, and it was passed that a letter of sympathy be sent to Mrs. Emil L. Massey and that letters of good wishes for an early recovery be sent to Mr. Hanske, Dr. Curtis, Mr. Frey, and Mrs. Mikesell.

The meeting adjourned at 11:05 P.M.

Saturday Morning Business Meeting

The meeting was called to order at 8:30 A.M. in the Tower Room by President John E. Potzger.

President Potzger expressed our sorrow at the loss through death of Mr. Emil L. Massey, a past president of CASMT, and Mr. Arthur T. Sims. The assembly stood in silence to pay tribute to the memory of these former members of CASMT.

Dr. Potzger expressed his gratitude to the members of CASMT for their loyal support during the past year. President Potzger said that while this had been a very busy year, it was one of the happiest years of his life; he thoroughly enjoyed every minute of his work with this organization.

The great contribution which the speakers had made to the Convention was noted. These speakers were as outstanding as their contributions to science and mathematics and it was satisfying to see that they, as well as CASMT, were recognized by numerous articles, pictures, and write-ups in the newspapers. In July not one of the speakers on the general programs was on the continent.

Mr. Leonhard moved, Mr. Vordenberg seconded, and the motion passed that the Association authorize the expenditure of fifteen dollars and forty-five cents for a floral tribute to Mr. Emil Massey.

Mr. Gingery gave a report on the anniversary publication. He called the attention of the members to the display of covers for the Gold Book which were on exhibit. He asked that each member cast his vote for the cover he preferred. Mr. Gingery assured the association that the Gold Book would be ready for the Convention in 1950.

Mr. Leonhard, chairman of the Membership Committee, reported that there were 1040 members at the beginning of the convention. At the convention 115 memberships had been received, but some of these were renewals. Out of a total of 50 memberships from Indiana, 43 of these were new. As of Saturday morning there were 209 members from Indiana in CASMT. Mr. Leonhard said that there were approximately 500 people in attendance at the convention.

Mr. Walter Gingery gave the following report of the Journal Committee:

> Pursuant to a policy adopted by the Board of Directors in May, 1946, the Journal Committee is recommending that the following seven members be made Emeritus members. This action of the Board provides that "Emeritus Memberships be awarded to those members who have both been association members continuously for 25 years and have retired from active teaching." It is, of course, impossible to assess or describe the extent of service rendered the Association by seven members whose faithfulness and loyalty have extended over a quarter century.

We are sure the Association hopes to retain in this Emeritus capacity the same sort of loyalty from these members for yet a long time to come.

This presentation does not have the pomp and ceremony that it deserves because plans were interrupted by the death of the chairman of the Journal Committee. However, it lacks nothing in sincerity.

H. Clyde Krenerick	Milwaukee, Wisconsin
Claude O. Pauley	Valparaiso, Indiana
M. E. Erwin	Monticello, Illinois
Herbert R. Smith	Baltimore, Maryland
Lillian Harwood	Chicago, Illinois
Robert B. Zika	Chicago, Illinois
Jennie M. Martin	St. Louis, Missouri

Mr. Gingery moved, Mr. Schreiber seconded, and it was passed that these seven members be elected to Emeritus Membership.

Mr. Vordenberg moved, Mr. Lefler seconded, and it was passed that the secretary write letters to exhibitors, speakers, and committee members thanking them for their cooperation.

Miss Royt gave the report of the Place of Meeting Committee. Miss Royt moved, Mr. Leonhard seconded, and it was passed that the 1949 Convention be held in Chicago.

Mr. A. O. Baker, chairman of the Nominating Committee, gave the following report:

President	Charlotte L. Grant Oak Park High School Oak Park, Illinois
Vice-President	Paul L. Trump University of Wisconsin Madison, Wisconsin
Board of Directors	Mary A. Potter, Board of Education Racine, Wisconsin Philip Peak, Indiana University Bloomington, Indiana Arthur C. Brookley, Thornton Township High School, Harvey, Illinois Martha E. Curtis, State Normal College Ypsilanti, Michigan

To replace Dr. Grant on Board of Directors for one year:
Ella Marth, Harris Teachers College, St. Louis, Missouri.
To replace Paul L. Trump on Board of Directors for one year:
Philip A. Tapley, Wells High School, Chicago, Illinois.

In the event that one of the nominated members to the Board cannot serve, Helen Trowbridge of Glenbard High School, Glen Ellyn, Illinois, is recommended to replace that member.

Mr. Lefler moved that the membership express its appreciation to the Nominating Committee for its splendid work and that the nominations be closed. Mr. Leonhard seconded the motion. The motion carried.

Mr. Baker moved, Mr. Mayfield seconded, and it was passed that the members selected by the Nominating Committee be elected.

Mr. Baker expressed the hope that it would be possible to have the 1951 Convention in Cleveland, Ohio.

President Potzger presented the newly elected President, Dr. Charlotte L. Grant, who expressed her appreciation of the trust and loyalty which the Association had extended to her.

Mr. Lefler called the attention of the members to the Indiana Science Talent Search which was being conducted and to the AAAS meeting in Washington, D. C., in December.

Mr. Lefler moved and Miss Potter seconded that sincere expression of appreciation be made to the President and to the Secretary for the good work they had

performed. The motion carried.

The meeting adjourned at 9:30 A.M.

THE SATURDAY AFTERNOON MEETING OF THE BOARD

The meeting was called to order by President John E. Potzger at 1:10 P.M. in Parlor E. The following were present:

Miss Mary A. Potter	Dr. Glen W. Warner	Miss Ella Marth
Dr. Charlotte L. Grant	Mr. Ralph W. Lefler	Mr. Philip Peak
Mr. Paul L. Trump	Mr. Donald W. Lentz	Mr. Philip Tapley
Mr. Ray C. Soliday	Mr. Lorne M. McKenzie	Mr. Fred Leonhard
Mr. Walter N. Smith	Mr. George E. Hawkins	

Mr. Enoch Burton of Shortridge High School gave his report on the statistics of the Convention. Of the 426 who registered, 310 were teachers, 116 were visitors.

Mr. Hawkins moved, Mr. Soliday seconded, and it was passed that the report of statistics be accepted and that the thanks of the Board be extended to Mr. Burton for his work.

Mrs. Johnson, editor of the Yearbook, reported that she was unable to obtain a bill from the printer in time to present a final report at this meeting. She thought that the Yearbook would pay for itself. The hotel rental was one hundred dollars less than at the Edgewater Beach Hotel. Other expenses of this year were about the same as last year's.

Mr. Hawkins moved, Mr. Soliday seconded, and it was passed that Mrs. Johnson's report be accepted with the thanks of the Board.

Mr. Carnahan, editor of the Gold Book, was encouraged to call a meeting in Chicago very soon in order to keep the activities in connection with the Gold Book moving toward their goals.

The question of whether or not the Board should establish some policy in regard to the use of advertising materials editorially at the section or general meetings was discussed.

Dr. Potzger presented the newly elected President of CASMT, Dr. Charlotte Grant, to the Board. Dr. Grant then took charge of the meeting.

Dr. Grant expressed her thanks and appreciation of the honor which had been awarded her. She expressed the need for the help, assistance, and cooperation of the Board in order to carry on her duties as President of CASMT.

President Grant suggested Dr. John E. Potzger and Miss Mary A. Potter as members of the Executive Committee. Mr. Trump moved, Mr. Lentz seconded, and it was passed that Dr. Potzger and Miss Potter together with President Grant constitute the Executive Committee.

It was decided that the spring meeting of the Board would be held in Chicago, Illinois on May 21, 1949.

Mr. Tapley moved and Miss Potter seconded that the May meeting of the Board of Directors be held at the Central Y.M.C.A., 19 South LaSalle St., Chicago, Illinois. The motion carried.

Mr. Lefler moved, Miss Potter seconded, and it was passed that Mr. Paul Trump be made chairman of the Resolutions and Policy Committee. As chairman he will have charge of the research projects.

Dr. Grant asked Mr. Trump to be chairman of the Resolutions and Policy Committee. Mr. Trump accepted the chairmanship.

The Board informally discussed the advisability of combining Sections of CASMT or of rearranging the scheduling of the general program and section programs. It was decided to refer this question to the Resolutions and Policy Committee for its recommendations.

Mr. Soliday moved, and Mr. Lefler seconded that the Board of Directors authorize the River Forest State Bank of River Forest, Illinois be used as depository of the funds of CASMT and that the Treasurer and President of CASMT be authorized as signatories of the checks. The motion carried.

It was suggested that a letter of appreciation be sent to the Art Department

of Washington High School for its work in providing sample covers to be used as suggestions for covers for the Gold Book.

Mr. Lefler moved, Mr. Lentz seconded, and it was passed that the future policy of the Association in regard to expressions of sympathy at the death of members be referred to the Resolutions and Policy Committee for suggestions.

Mr. McKenzie moved and Mr. Lefler seconded the motion that we adjourn. The motion carried.

The meeting adjourned at 2:15 P.M.

The minutes of the three meetings are respectfully submitted.

CECILIA J. LAUBY, *Secretary*

THE SECTION MEETINGS

The various section meetings of the Association held on Friday afternoon and the Group meetings held on Saturday morning met the high standards established in the general meetings. Officers for the sections were elected in accordance with the by-laws of the Central Association of Science and Mathematics Teachers. The full roster of officers for 1948–49 appears in this issue of the Journal.

CECILIA J. LAUBY, *Secretary*

BIOLOGY SECTION

Miss Helen Trowbridge, chairman of the biology section, called the meeting to order on Friday afternoon at 2:15 P.M. in the Tower Room of the Claypool Hotel and introduced the first speaker, Dr. E. Lawrence Palmer, of Cornell University, Ithaca, New York. Dr. Palmer gave an address on "Some Contributions of the Elementary Science Textbook Writers to The Problems of the Secondary School Science Teachers." His paper was prepared in the hope that it will in some measure improve the quality of elementary science texts and contribute to the development of standards that will increase the respect for such texts. Criticism was directed to three series of texts. Many of the weaknesses which appear in these series were found to be common to all three series. Dr. Palmer's paper was prepared on the following assumptions: that it is undesirable for untruths to be taught which must be corrected at a later time; that it is desirable for students in elementary science to gain an appreciation of method as well as content in science; that it is desirable for content to be significant to the learner immediately and even more significant later; that it is desirable that texts have been submitted for critical analysis to qualified academic specialists before they are ever published; that it is desirable that texts be properly evaluated for language, type and grade placement by qualified experts in the pertinent levels; that it is desirable that the use of exotic materials be avoided where superior or equally valuable immediate materials are available for use; that it is desirable that teleology, anthropomorphism and dangerous analogies be avoided wherever possible; that it is desirable that the science offerings recognize certain merit when rationally integrated with work in social science and should also provide some opportunity for developing appropriate technical skills that may have a bearing on success in industry or in general living; that it is desirable that content of elementary science texts be related to the experience background of the student and integrated well with the immediate needs of the user of the book; that it is desirable that every word in every text and every illustration shall have been read and approved by the authors listed as assuming responsibility for the different books.

Dr. Palmer then cited numerous examples of violations of these basic assumptions. In evaluating the texts, two kinds of criticism were considered: those that were of a philosophical, subjective and therefore controversial type, and those of a factual, possibly objective and not of a controversial type. Many errors pointed out by Dr. Palmer indicated that not one of the books, mentioned in the series studied, could have been submitted in manuscript form to qualified specialists in the various fields involved.

Mr. A. C. Brookley, Thornton Township High School, Harvey, Illinois, chairman of the nominating committee, recommended the officers for the coming year.

The report of the nominating committee was accepted by unanimous ballot. The officers for 1949 are:

Chairman—Dr. Robert H. Cooper, Associate Professor of Biology, Ball State Teachers College, Muncie, Indiana.

Vice-chairman—Mr. Donald B. O'Brien, Biology Instructor, Thornton Township High School, Harvey, Illinois.

Secretary—Miss Frances M. Gourley, Biology Instructor, LaPorte Senior High School, LaPorte, Indiana.

Dr. John J. Miller, Director of Clinical Research for J. B. Roerig & Co. (Specialists in Vitamins), Chicago, Illinois, spoke on "The Greatest Miracle." While we have done much to conquer many diseases of the infectious type, we have neglected the problem of non-infectious ailments such as: arthritis, gastric ulcers, diabetes, multiple sclerosis, colitis, muscular dystrophy, hypertension and heart diseases. These conditions are much too common in this supposedly scientific age. To acquire and maintain health, we must understand it and the public must be educated as to the possibilities and processes of bodily health. This means that we must comprehend the physiological and chemical processes which make for efficiency and normalcy in this wonderful organism. This was illustrated by considering in detail the marvelous system by which walking is accomplished. The various phases of muscle action and the removal of by-products are activated or benefited by the presence of practically all the vitamins. An analysis was given of the chemicals, enzymes and vitamins concerned in several ailments. The relationship of nerve action and thought impulses to muscular action was then brought out and it was noted that vitamins also play an important role in regard to nerve health and functioning. Literally hundreds of detailed reactions and an equal or greater number of chemical substances are produced and utilized in the voluntary movement of a muscle. Moreover, these reactions occur under very carefully controlled, yet self regulated conditions.

The body is much more remarkable than any factory, for in our neuromuscular systems, a thousand chemical compounds must be made in less than millionths of a gram quantities, in fractions of a second, and in a microscopic enclosure. To rebuild nerves and myelin sheaths, and to re-educate degenerate muscles, there must be available not only the needed vitamins, minerals, and other essential food factors, but also the "will power" required to start these regenerative chemical processes. This will power is closely intertwined with a concept which is usually called "faith." Needless to say, the "Greatest Miracle" refers to the one we take mostly for granted—the human body!

Dr. Charlotte L. Grant, Head of the Biology Department at the Oak Park Township High School, Oak Park, Illinois, spoke on the topic: "Health Science—a part of the Biological Curriculum at Oak Park." A "Health Science" course is required of all freshmen at Oak Park. It takes one semester and is taught by the regular biology faculty. The course is made up of four units:

Unit I: "The Human Body—A Machine"—In this unit a study is made of the human body and how it works. It is studied not as unrelated parts, but as an integrated whole. On this basis, attitudes, practices and appreciations are then built up.

Unit II: "The Young Person at Home"—This unit is concerned with such topics as: diet, health habits, mental hygiene, housing, sanitation, safety in the home, and closes with community health.

Unit III: "The Young Person at School"—This discusses such things as the physical aspects of lighting, heating and ventilation, program of the school day as affecting health, accidents, safety, and some first aid.

Unit IV: "The Young Person at Leisure"—It includes sports, hobbies and other types of leisure time activities with final emphasis on normal, healthy activities that make good use of leisure time. Drinking, smoking and use of stimulants and sedatives are considered here on request of students.

This course is coordinated with teaching in other departments of the school. A school health council has also been organized, which includes in its members—

the heads of certain departments, administrative personnel concerned with health problems, cafeteria manager, and school nurse. Cooperation with community health agencies is in progress.

Manuscripts of the addresses by each of the above speakers will be made available for publication in the Journal.

D. B. O'BRIEN, *Secretary*

CHEMISTRY SECTION

Mr. Allen Meyer of MacKenzie High School, Detroit, Chairman of the Section, called the meeting to order in the Empire Room of the Claypool Hotel. Mr. Meyer introduced Vice Chairman Carl E. Ekblad of the Senior High School, Moline, Illinois and Secretary Clyde W. Dewalt of Glenbard Twp. High School, Glen Ellyn, Illinois.

The first speaker, Dr. Brooks Fortune, of the Lilly Research Laboratories, Indianapolis, Indiana, discussed the history, source, and importance of the production of antibiotics. Special attention was given to penicillin and streptomycin. Mention was made of the discovery and development of penicillin; particularly, of two phases of the work carried on at the Northern Regional Research Laboratory. These important developments had to do with increasing the quantity and purity of penicillin. The discussion was supplemented by the use of numerous slides showing the names of several important antibiotics, the structure of several types of penicillin, and many processes as they are utilized in the manufacture of antibiotics at the Lilly Research Laboratories.

Mr. Walter Geisler of Shortridge High, Indianapolis, appeared on the program in the absence of his colleague, Mr. Frank B. Wade. He gave an interesting account of a class project carried out by the more advanced chemistry classes at Shortridge High School, under the supervision of Mr. Wade. The project dealt with the role of minerals in determining color in turquoise. Mr. Geisler commended Mr. Wade for his interest in boys and girls. He also praised the interest of the Shortridge students in the project. It is interesting to note that a report of this work will be published in London, England, and the results of the project are being further considered by the University of Minnesota.

The program closed with the presentation and discussion of a circular model of the Periodic Chart, by Dr. George A. Scherer of Earlham College, Richmond, Indiana. Dr. Scherer stated that this arrangement of the Periodic Chart placed the elements on a continuous curve, providing a clear classification of the typical elements, transitional elements, and rare earths. A brief, but enthusiastic, discussion indicated considerable interest in the project.

Early in the program Mr. Arthur Reynolds of Detroit, chairman of the nominating committee, presented the following slate of officers for the coming year:

Chairman: Mr. Carl E. Ekblad, Senior High School, Moline, Illinois.

Vice-Chairman: Clyde W. Dewalt, Glenbard Twp. High School, Glen Ellyn, Illinois

Secretary: Dr. Gerald Osborn, Western Michigan College, Kalamazoo, Michigan

The slate was unanimously elected.

CLYDE W. DEWALT, *Secretary*

ELEMENTARY MATHEMATICS SECTION

The Elementary Mathematics group held its meeting Friday, November 26 beginning at 2:15 P.M. Mr. Joseph J. Urbansek presided. There were about twenty-five members present.

J. R. Mayor, Associate Professor, School of Education, University of Wisconsin gave an interesting address on the vital subject, "Special Training for Teachers of Arithmetic." Mr. Mayor presented the evidence which makes the need for training necessary both from the standpoint of in-service teachers and those teachers who are now being trained. Many valuable suggestions were given as aids for improvement of teachers.

The second part of the program was a presentation of "The Spiral Develop-

ment of Arithmetic" by Mrs. Lucile B. Gates, Assistant Principal of the Sawyer Elementary School of Chicago. The various steps in the development of Arithmetic were visualized on a chart in spiral form starting with the simplest and moving toward the more complex.

The manuscripts of both speakers will appear later in SCHOOL SCIENCE AND MATHEMATICS.

E. E. Cowley, *Acting Secretary*

GEOGRAPHY SECTION

The meeting was called to order at 2:15 by the section Chairman, Ester Arthur of South Shore High School, Chicago. After the brief formalities, Dr. Floy Hurlbut, who has lived in China eleven years and has many friends in China, was most interesting in her observations, entertaining, as well as sincere in her delivery. Many questions were answered in the informal discussion following her talk.

Dr. Hurlbut emphasized the following points:

Aviation has eliminated space. A trip from Minneapolis to Shanghai via Northwest Airlines takes only thirty-nine hours of flying time. China has changed. Many of the country places still travel and live in primitive fashion; The cities are being modernized and air transportation has become popular. The Chinese republic is young, only thirty-seven years last October tenth. It has not yet reached perfection, but the youth of the country are eager and alert. The country is worthy of our interest and help.

The following section officers were chosen for the year 1949.

Chairman: Dr. Floy Hurlbut, Ball State Teachers College Muncie Indiana.
Vice Chairman: Laura Watkins, Lincoln School Cicero, Illinois.
Secretary: Mabel Washburn, Shortridge High School Indianapolis, Indiana.

ESTER ARTHUR, *Acting Secretary*

GENERAL SCIENCE SECTION

Mr. Milton O. Pella, chairman, called the annual meeting of the General Science Section to order at 2:15 P.M. on November 26, 1948. He introduced Dr. Morris Meister, Principal, High School of Science, New York, N.Y. Dr. Meister spoke on his "Thirty Years of General Science Teaching." In his opening remarks, Dr. Meister said he'd learned the value of perspective during his 30 years in the classroom, as a supervisor and in teacher training. He divided the development of General Science teaching into 10 eras as follows: 1. Era of Herbert Spencer and the natural philosophy with its basis for demonstration teaching, from 1875 to 1900. 2. Era of specialization with college domination and the laboratory approach, 1900 to 1910. 3. Era of everyday application in which Thorndike et al developed their theories of learning, from 1910–1920. Then followed several developments approximately 5 years each. 4. Era of Civic Science with emphasis on citizenship values. 5. Era of environmental interpretation making use of real life and child experiences and interests. 6. Era of generalizations given impetus by the publication of the 31st Yearbook in 1935. 7. Era of experience and activity organization swinging back from individual laboratory experiences to group demonstrations. 8. Era of relationships based on the core curriculum. 9. Era of child development, our present period of democratic procedures with both general education and stimulation for the talented being attempted. 10. A glimpse into the future in which General Science becomes part of a planned sequence of Science studies. This would mean a two track program in which (1) the emphasis for the larger percentage of pupils would be their growth and behavior changes, while (2) the smaller percentage going to college would be taking traditional course sequences.

Mr. Ira C. Davis reported for the nominating committee and the following officers were elected for 1949:

Chairman: Donald A. Boyer, Skokie Junior High School, Winnetka, Illinois.

Vice-Chairman: Russel Shedd, Redford Union High School, Detroit, Michigan.
Secretary: Fred W. Fox, McGuffey High School, Oxford Ohio.

Dr. Wilbur L. Beauchamp, Associate Professor in the Teaching of Science, University of Chicago, spoke on "Methods of Teaching Science." He stated that methods were the same as in 1915, the changes were merely in terminology. It is, he said, a case of "old principles with new faces." He then briefly reviewed some of the principles of learning. As applied to General Science teaching there are three steps in the acquisition of knowledge: 1. Becoming aware of the world about us. 2. Reflective thinking (hypothesis, evidence and conclusion). 3. Appreciation or understanding acquired through stimulus, assimilation or experience getting, and reaction. Dr. Beauchamp then proceeded to illustrate his thesis by development of a lesson on the topic: "Evaporation Cools." He carried it through from raising a problem in the pupils' minds to the iultimate useful aspects in everyday life. In doing this he listed on a blackboard three columns headed: Conditions, Effect(s), and Explanation as a logical guide for each activity suggested. This to develop ultimately some reflective thinking. He emphasized the need for a great many items in each of these three columns and closed with this thought: "We stop short of understanding by lack of practice."

RUSSEL SHEED, *Secretary*

MATHEMATICS SECTION

The meeting was called to order at 2:15 P.M. by the chairman, Mr. Philip Peak of the University High School, Bloomington, Indiana. Mr. Peak introduced the other officers of the section, Vice-Chairman W. H. Edwards, Redford High School, Detroit, Michigan and Secretary E. H. C. Hildebrandt, Northwestern University, Evanston, Illinois. It was agreed to dispense with the reading of the minutes of the previous meeting.

The chairman appointed the following persons to serve on a nominating committee of section officers:

Miss Fern Hodson, Newcastle, Indiana
Mr. Glenn F. Hewitt, Chicago, Illinois
Mr. Fred D. Leonard, Detroit Michigan

This committee later reported their recommendations for 1949 as follows:
Chairman: Mr. W. H. Edwards, Detroit, Michigan
Vice-Chairman: Mr. E. H. C. Hildebrandt, Evanston, Illinois
Secretary: Mr. Enoch D. Burton, Indianapolis, Indiana.
This report was approved.

The entire program which followed, presented a review of present trends in mathematics teaching in the secondary schools. "Modern Trends in Secondary Mathema tics" were discussed by Mr. W. D. Reeve of the Mathematics Department of Teachers College, Colombia University. Mr. Reeve pointed out that there were such good trends as the present tendency to emphasize meanings or understandings, to organize the curriculum along general mathematics lines, to recognize individual differences in ability and to use more multi-sensory aids in the teaching of mathematics. Certain bad trends which should be discouraged were also considered, such as omission or postponement of certain topics, leveling down instead of leveling up in content, and mechanical teaching.

In a panel discussion on "Current Experiments in Mathematics Teaching," Mr. H. Vernon Price, University School, The University of Iowa, Iowa City, Iowa, described "An Experiment in Fusing Plane and Solid Geometry" into a one year course which has been carried on during the past four years. He discussed the content of the course, typical classroom activities and the problem of measuring achievement. In a second paper, in this panel, entitled "An Attempt to Measure Critical Judgement," Mr. Bjarne R. Ullsvik, Illinois Normal University, Normal, Illinois, pointed out that few textbooks teach for critical thinking and that further consideration must be given to test items which show the ability to judge conclusions, the understanding of meanings of terms, and to discover flaws in arguments used in mathematics and in everyday situations.

A report was also presented by the Trends Committee consisting of Mr. Phillip S. Jones, Chairman, University of Michigan, Ann Arbor, Michigan; Miss Virginia Terhune, Proviso Township High School, Maywood Illinois; Miss K. Eileen Beckett, High School, Lebanon, Indiana; and Mr. H. Vernon Price, University School, University of Iowa, Iowa City, Iowa. Copies of the report were distributed to the members of the section and included references to several trends mentioned by previous speakers on the program as well as pointing out several problems and projects which are being studied at the present time.

The meeting adjourned at 4:15 P. M.

E. H. C. HILDEBRANDT, *Secretary*

BOOKS AND PAMPHLETS RECEIVED

PRACTICAL SHOP MATHEMATICS, Volume I—Elementary, by John H. Wolfe, Sc.D., Formerly Director of Apprentice Training, Ford Motor Company; and Everett R. Phelps. Ph.D., Professor of Physics, Wayne University. Third Edition. Cloth. Pages xii+371. 11.5×19.5 cm. 1948. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $2.40.

ADVENTURES WITH ANIMALS AND PLANTS, by Elsbeth Kroeber, Assistant in Biological Science and Administrative Assistant at the Midwood High School, Brooklyn, New York; and Walter H. Wolff, Principal of the William Cullen Bryant High School, Queens, New York. Cloth. Pages xii+600. 16×23.5 cm. 1948. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $3.20.

THE CHEMICAL ARTS OF OLD CHINA, by Li Ch'iao-p'ing, National Northeastern University, Mukden, China. Cloth. Pages viii+215. 14.5×23 cm. 1948. Journal of Chemical Education, Easton, Pa. Price $5.00.

BOY'S BOOK OF SNAKES, HOW TO RECOGNIZE AND UNDERSTAND THEM. by Percy A. Morris, Chief Preparator, Peabody Museum of Natural History, New Haven. Cloth. Pages viii+185. 15.5×23.5 cm. 1948. The Ronald Press Company, 15 E. 26th Street, New York 10, N. Y. Price $3.00.

A CONCISE HISTORY OF MATHEMATICS, by Dirk J. Struik, Professor of Mathematics at the Massachusetts Institute of Technology. Volume 1, The Beginnings—The Beginnings in Western Europe. Pages xviii+123. Volume II, The Seventeenth Century—The Nineteenth Century. 176 pages. Cloth. 10.5×16.5 cm. 1948. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price each $1.50. Set $3.00.

SOLID GEOMETRY, by James Sutherland Frame, Professor and Head of the Mathematics Department, Michigan State College, East Lansing, Michigan. Cloth. Pages ix+339. 13.5×20 cm. 1948. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $3.50.

MAKING SURE OF ARITHMETIC, Grade I, by Robert Lee Morton, College of Education, Ohio University, Athens Ohio; and Merle Gray, Director of Elementary Education, Hammond Public Schools, Hammond, Indiana. Paper. 144 pages. 20.5×28 cm. 1948. Silver Burdett Company, 45 East 17th Street, New York 3, N. Y. Price 60 cents.

TEACHER'S GUIDE TO ACCOMPANY MAKING SURE OF ARITHEMTIC, Grade One, by Robert Lee Morton and Merle Gray. Paper. Pages vi+226. 13.5×20.5 cm. 1948. Silver Burdett Company, 45 East 17th Street, New York 3, N. Y. Price 88 cents.

MAKING SURE OF ARITHMETIC, Grade Two, by Robert Lee Morton, and Merle

Gray. Cloth. Pages iii+252. 14×20.5 cm. 1947. Silver Burdett Company, 45 East 17th Street, New York 3, N. Y. Price 60 cents.

TEACHER'S GUIDE TO ACCOMPANY MAKING SURE OF ARITHMETIC, Grade Two, by Robert Lee Morton, and Merle Gray. Paper. Pages viii+336. 13.5×20.5 cm. 1947. Silver Burdett Company, 45 East 17th Street, New York 3, N. Y. Price $1.00.

STUDENT'S HANDBOOK OF SCIENCE, by Bernard Udane, and Herman W. Gillary, Science Department, Forest Hills High School, New York, N. Y. Paper. 208 pages. 12.5×19.5 cm. 1948 Frederick Ungar Publishing Company, 105 East 24th Street, New York 10, N. Y. Price 75 cents per copy and orders for 10 or more 60 cents per copy.

SUGGESTIONS FOR SCIENCE TEACHERS IN DEVASTATED COUNTRIES, prepared by J. P. Stephenson. Paper. 88 pages. 15×24.5 cm. 1948. United Nations Educational Scientific and Cultural Organization, Onesco House, 19 Avenue Kleber, Paris 16.

SPONSORING THE SCIENCE CLUB, by George Greisen Mallinson, Assistant Professor of Teaching of Science, Iowa State Teachers College, Cedar Falls, Iowa Educational Service Publication, Issue No. 8, June 1948. 18 pages. 15×23 cm. Iowa State Teachers College, Cedar Falls, Iowa. Price 15 cents.

THE CLINICAL USE OF CRYSTALLINE PENICILLIN G. Paper. 24 pages. 17×23 cm. 1948. Merck and Company, Inc., Rahway New Jersey.

ARITHMETIC 1948, Compiled and Edited by G. T. Buswell. Supplementary Educational Monographs, Number 66, October, 1948. Pages v+90. 16.5×24 cm. University of Chicago Press, 5750–58 Ellis Avenue, Chicago 37, Ill. Price $2.50.

INTELLECTUAL ABILITIES IN THE ADOLESCENT PERIOD, by David Segel, Specialist, Tests and Measurements. Bulletin 1948, No. 6. Pages v+41. 14.5×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 15 cents.

INDIANA AUDUBON SOCIETY 1948 YEARBOOK. Paper. 78 pages. 14×23 cm. Vol. xxvi.

BOOK REVIEWS

THE STRANGE STORY OF THE QUANTUM, by Banesh Hoffmann, *Department of Mathematics, Queens College, New York.* Cloth. Pages xi+239. 13.5×20.5 cm 1947. Harper and Brothers, 49 E. 33rd Street, New York 16, N. Y. Price $3.00.

On the title page of this book is the following: "An account for the GENERAL READER of the growth of the IDEAS underlying our present ATOMIC KNOWLEDGE." An understanding of what is meant by the "general reader" is needed. The reviewer handed the book to four educated individuals, each having obtained the M.A. degree from a well recognized university. One degree represented a major in English, a second in history, a third in psychology, and a fourth in chemistry. One continued school, obtained a Ph.D. degree and is now a college professor; a second qualified for the M.D. and is now a well recognized and competent practicing physician; a third is a high school teacher; the fourth is a successful business man and community leader. All answers came back stating that the reader did not understand the discussion; the many questions asked in the book

were never answered. One stated that the book gave no idea of what was meant by a *quantum*.

This test seems to take the book entirely out of the class for whom it was written. The author takes us from the early ideas of Thomson, Soddy and Rutherford through the contributions of Planck, Bohr, Pauli, de Broglie, Heisenberg, Dirac, Schrodinger. In addition something of the contributions made by Hamilton, Maxwell, Hertz, Sommerfeld, Einstein, Compton and many others should be known. The p's and q's and ψ's need introduction and the strange arithmetic they demand should be explained. What did the Curies, Anderson, Lawrence, and Meitner do that brings their names into the book? The demand is a pretty thorough knowledge of modern physics or the simplest sentences will fall without meaning. For those with sufficient background the book is absorbing, but it does not tell the lay reader much and should not be so advertised.

G. W. W.

THE ELECTRON MICROSCOPE, by Dr. D. Gabor, *Engineer, British Thomson-Houston Company, Ltd., Research Laboratory, Rugby.* Cloth. Pages viii+164. 13.5×20.5 cm. 1948. Chemical Publishing Company, Inc., Brooklyn 2, N. Y. Price $4.75.

This is the American edition, somewhat extended in the light of recent progress in the field, of a book that first appeared in England. It begins with chapters on electron optics, both ray and wave, and shows how the results obtained can be applied to the production of lenses that will form images with electrons rather than light waves. These are followed by a discussion of the achievements and limitations of electron microscopy. Several commercial microscopes are described briefly.

The treatment is in the main descriptive and nonmathematical, such equations as are used being introduced in general without derivation. Diagrams and photographs illustrate the principles and suggest the kind of use to which an electron microscope can be put.

The book provides a useful introduction to the subject, which can be followed further with the aid of an extensive bibliography. The non-scientific reader will find it not too hard going, though he will have to take on faith many of the author's statements. Some smoothing of the English, in which the author is not entirely at home, would have improved the impression that the book makes.

The price seems high for so small a book, even in these times.

JOSEPH D. ELDER

COLLEGE PHYSICS, by Henry A. Perkins, Sc.D., *Professor of Physics, Emeritus, Trinity College.* Third Edition. Cloth. Pages x+786. 14.5×23 cm. 1948. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $6.65.

The first edition of this book appeared ten years ago, and was remarkable, among other reasons, for the number of topics that it treated. The new edition has been brought up to date in radar and atomic energy, for instance, without undue expansion as a whole, some topics having been compressed or eliminated.

The order of presentation is the traditional one—mechanics, heat, wave motion and sound, light, electricity and magnetism, corpuscular physics. Within these subdivisions the author provides a wealth of material, believing that "to eliminate all but the bare bones is doing the student a great injustice."

The teacher who feels—some, unfortunately, have reason to be certain—that his students cannot digest so full and varied a diet will choose a less extensive treatment of the subject, believing that to learn a little physics thoroughly is better than to acquire only vague ideas about a great deal. The more fortunate teacher whose students are able and anxious to learn all the real physics they can get will welcome Professor Perkins's textbook. As the many users of the earlier editions would expect, it is a thorough, complete and extremely clear presentation.

JOSEPH D. ELDER

NUCLEAR RADIATION PHYSICS, by R. E. Lapp, Ph.D., *Research and Development Board, Washington, D. C.*, and H. L. Andrews, Ph.D., *National Institute of Health, Bethesda, Maryland.* Cloth, Pages xiv+487. 14×21.5 cm. 1948. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $6.00.

This is a textbook in the part of physics that is of greatest interest at present to the nonphysicist. It deals with the production, measurement and use of nuclear radiations. To be made understandable to one whose training has not been in physics, these subjects require some back-ground in atomic structure, electricity, and quantum theory. This background the authors provide, without using mathematics beyond simple algebra, but sufficient for the purpose.

The major portion of the book, as the title indicates, is concerned with the nucleus of the atom and the particles that can be got out of it. Perhaps it is indicative of the extremely rapid progress that has been made in this field since 1940 that only one chapter is devoted to natural radioactivity. This is followed by chapters on artificial radioactivity, nuclear reactions, nuclear fission and the nuclear chain reaction.

Instruments and techniques for measuring or detecting nuclear radiations are described in some detail. There is a valuable chapter on radioactive tracer techniques, and the book closes with a discussion of the newest branch of physics, but one that has already acquired extreme importance—health physics. This subject deals with the effect of nuclear radiations on body tissue, biological effects of radiation, safety measures and the disposal of radioactive wastes. These topics are of paramount importance in the handling of the relatively immense quantities of radioactive material now available from nuclear piles.

Problems, without answers, are provided at the end of each chapter, so that the student may acquire some familiarity with the types of calculation involved. The book is well printed and amply illustrated. It will be of interest and value not only to students of physics but to biologists and physicians who use nuclear radiations as tools for research and to anyone else who wants a thorough and readable but not mathematically intricate discussion of this highly important and interesting subject.

JOSEPH D. ELDER

THE STORY OF SOUND. by James Geralton, *Instructor in Physics Harvard University.* Cloth. Pages 1 to 74. 13×20 cm., Copyright 1948, Harcourt, Brace and Company, 383 Madison Ave., New York 17, N. Y. Price $2.00.

The author presents in the language of the young the mechanics and nature of sounds. Included are sounds made by living organisms as well as those made by musical instruments and radar. The presentation is scientifically correct but it is garbed in the language of the young and the layman. The book is perhaps written specifically for junior high school age but it will make excellent supplementary reading for freshmen and sophomores in high school. The illustrations are simple but they are well woven into the flow of the story. A very readable book.

J. E. POTZGER

RINGS AND IDEALS, by Neal H. McCoy, *Professor of Mathematics, Smith College.* Cloth. Pages xii+216. 12×19 cm., 1948. The Mathematical Association of America, University of Buffalo, 14, New York.

This is number 8 in the series of Carus Mathematical Monographs, which have as their purpose expository treatment of various mathematical subjects.

This particular monograph presents an introduction to that branch of abstract algebra having to do with the theory of rings, with some emphasis upon that portion of the theory which deals with ideals.

Although no previous knowledge of abstract algebra is assumed, the reader is expected to have a considerable amount of mathematical maturity, for example within the first ten pages one encounters the concepts: addition and multiplica-

tion of matrices; congruence modulo m; Abelian group.

The first chapter is especially readable. A considerable number of examples of rings are presented. Again, the brief introduction to the algebra of logic, presented in connection with Boolean rings is well presented.

Some idea of the scope of the material may be shown by a few of the chapter headings: Ideals and Homomorphisms; Prime Ideals in Commutative Rings; Imbedding Theorems; Rings of Matrices.

Each chapter is followed by a list of references supplementing the material of the chapter; the back of the book contains a bibliography which the author states is not complete.

There are no lists of problems; the purpose of the book is an expository treatment, rather than a textbook, and collection of exercises.

CECIL B. READ

DIAGNOSTIC AND REMEDIAL TEACHING IN SECONDARY SCHOOLS, by Glenn Myers Blair, Ph.D., *Assistant Professor of Educational Psychology, University of Illinois*. Cloth. Pages xv+422. 13×20.5 cm. 1946. The Macmillan Company, 60 Fifth Avenue, New Yrok, N. Y. Price $3.25.

The fact that twenty to thirty percent of all pupils entering high school can read only with great difficulty, and that more than seventy percent of seventh and eighth grade pupils need corrective instruction in arithmetic, raises a variety of questions. Is it the pupil or the teacher? Is it the system of education or the kinds of teaching material used? Is it any one or a number of factors? To answer questions of this sort we need a book by a competent authority. Such a book should tell us not only what is the matter, but also what to do. Dr. Blair's book supplies this need.

After defining the need for remedial teaching and the meaning of such teaching, he devotes a full chapter to the means by which poor readers can be located. Observing pupils at study, using graded books, studying eye movements, and using tests, are some of the methods he presents. Following this, in an exhaustive and carefully prepared chapter, he covers at once the causes and the diagnostic techniques involved in poor reading.

Now that he has disposed of diagnosis, Blair turns to remedial work. In four chapters following, he takes up methods for improving vocabulary, speed, and comprehension; and then proceeds to list the practices which have been tried and found adequate the country over in both junior and senior high schools. The last of these chapters includes sources of information and lists of books for the use of corrective therapists (or remedial teachers).

A long chapter is dedicated to arithmetic, following in general the same scheme as the chapters on remedial and diagnostic reading. Causes of difficulty and remedial procedures on the junior and senior high school levels are given in detail.

Supplementary chapters deal with spelling, handwriting, and fundamentals of written English. The last chapter reports techniques in making case studies, and gives illustrative case material.

M. H. KROUT

GENERAL MATHEMATICS IN DAILY ACTIVITIES, by Walter W. Hart, Author of Mathematics Textbooks, Formerly *Associate Professor of Mathematics, School of Education, University of Wisconsin*, and M. Cottell Gregory, *Teacher of Mathematics, Louisville Girls High School, Louisville, Kentucky*. Cloth. Pages vii+406. 13.5×20.5 cm. 1948. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $2.00.

I have divided the book into four parts, namely, (1) geometry and algebra, (2) socialized mathematics, (3) arithmetic review, and (4) mathematical tools. I would like to discuss each part separately.

Part 1 is a presentation of geometry and algebra with insertion of skills necessary for the various processes as rounding off numbers in the presentation of

graphs. The author does make the topics practical and explains to the student why each is used and how it is used. This part consists of Units 1 through 4. No formal geometry or algebra.

Part 2, the socialized mathematics is divided into 4 main topics, namely home life problems, leisure time problems, vocational problems, and community problems. We should not turn out students to become home makers without arming them in some way against loan sharks, poor insurance coverage, etc. but the mathematics teacher has to become a jack of all trades to teach it; for the student is usually not content with mere book problems and explanations but wants the teacher to solve problems his family has encountered. This book does have more realistic problems than the usual socialized mathematics but pupils are still to find the rate of insurance of Mr. A and to find the premium, but what happens when Mr. A can not pay a premium? Some of the items should be selected for the class as home sewing and cooking will be dull to boys, farm problems dull to girls, etc. There is an excellent section on clerking in a store, it tells how to make change, how to make out sales slips and other details.

Part 3, the arithmetic review, is very near the end of the book. This is inserted at the back of be used when needed so that the interest of the student will not lag. The fundamentals of arithmetic are well presented. The author explains the how and why of every operation, he avoids the tendency for the student to do things mechanically and automatically without thought of why it is done that way. There is excellent drill material also. You will like the explanation with each arithmetic process. It imforms the mature student of what he has been doing for years and why he did it.

Part 4, more mathematical tools, discusses positive and negative numbers and leads the way to more algebraic equations, as well as formulas which take the student into a more detailed study of geometry. This part also discussed indirect measurement and an introduction to trigonometry developing the table of tangents and working problems with it.

In summary, I would like to say this book has many things an 8th or 9th grade class might want. There is work for the slow student with a good review of arithmetic fundamentals and there is work for the better student. You can see the variety of topics presented in the various parts. If you are looking for a generalized text, I suggest you take a look at this book before deciding.

ETHEL KORTAGE

PREPARING FOR FEDERAL RADIO OPERATOR EXAMINATIONS, by Arnold Shostak. 342 pages+list of figures, index, and appendixes. New York: Prentice-Hall, Inc., 1948. Price: $3.75.

The author of this book was formerly a Radio Inspector for the Federal Communications Commission. The Federal Communications Commission has prepared a list of questions from which are chosen the sets of questions in the F.C.C.'s operators' examinations. This list of questions is reprinted in the book, along with the appropriate answers.

In addition to developing brief, and yet complete and rigorous answers the author has in many of the technical type questions gone beyond this by reviewing the theory and reason basically needed for understanding the problem. This means that while the book itself is far from being complete enough to be considered a textbook, yet it gives enough information in significant places so that those studying for the examination and possessing a background of fact and theory will probably need no other book during their study of this self-coaching course.

The diagrams have been well constructed and reproduced in a convenient size for easy study. The answers and explanations have a large number of illustrations to assist one's understanding of the problems presented. To help the reader, both the figures and topical material are well indexed.

While this book is intended for those who plan to take the commercial grade radio operator's examination, it would also prove useful to the prospective amateur radio operator. Moreover. it would serve as an excellent reference book for

those who have already passed one or more of the operator's examinations and desire a ready source of answers for problems that occur from time to time in the operation of radio equipment.

SHAILER PETERSON

A "TRIG" STUDENT'S LAMENT

JOSEPH J. URBANCEK
Chicago Teachers College, Chicago, Illinois

Sometimes, as teachers, we receive from our particularly good students bits of humor, wisdom, or philosophy which make us chuckle and lighten our wearisome load in an otherwise routine day. The poem given below may not elevate the standards of writing poetry but it should give many a mathematics teacher something to smile about. H. M. G. submitted it to me as shown below.

THE *SINE* IS MY UNDOING

T'was just before midnight,
When all through my brain,
Not a brain cell was working,
Nor was I sane.

I sat there a-wondering,
What formulas I used,
But the more I sat thinking,
The more I got confused.

I knew I had to study,
I knew I had to think,
But enough is enough,
To drive me to drink.

I tried very hard,
To get my *sines* straight,
But I knew this exam,
Must be left up to fate.

Cosines and *sines*,
Around me "glore,"
Tangents and *cotangents*,
Then even more.

Had just succeeded,
In finding a clue,
When what should come up,
But a *secant* or two.

Sometimes I wonder,
Who invented my "trig,"
For whoever it was,
Should be put in the brig.

A university—an institution consciously devoted to the pursuit of knowledge, the solution of problems, the critical appreciation of achievement and the training of men at a really high level.—ABRAHAM FLEXNER.

Don't discount the profession of teaching. In starting the growth of outstanding careers in science you have done more for science than anyone in her service.—CARL F. HANSKE.

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